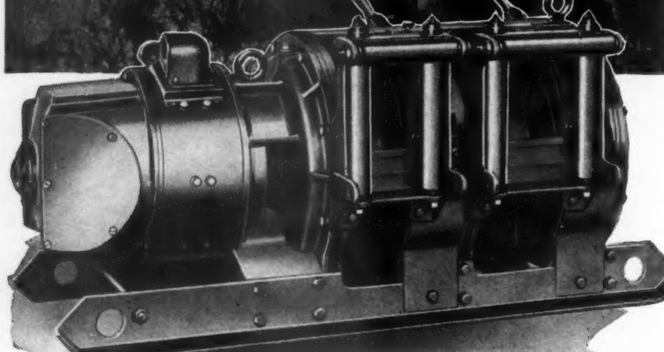
Compressed Air Magazine

Vol. 42, No. 7 | London - New York - Paris | July, 1937

MARVELS OF THE MODERN GLASS MAKER (See Page 5361)



CORRECTIONS

IN THE article, *Compressed Air in a Super Sawmill*, published in the May issue, it was stated on page 5311 that the daily output of the Long-Bell sawmill is equivalent to a tongue of 1x12-inch boards more than 23 miles long. This should have been the hourly-production equivalent. In the same issue there are two typographical errors in the article *Pacific Coast Utility Driving 11-Mile Tunnel*. The name of one of the early-day desperadoes was given as Black Hart instead of Black Bart, and Angels Camp, the name of a mining settlement, appeared as Angles Camp.

•

ON THE COVER

IN THE picture are shown the various forms of fibrous glass made by the Owens-Illinois Glass Company, through whose courtesy the photograph is reproduced. Among them are bats of wool-like material for various insulating purposes, yarn to be woven into textiles such as the piece of cloth at the right, and, in the frame, criss-crossed coarse fibers which serve to filter the intake air of compressors, diesel engines, etc. The wall in the background is composed of hollow glass building blocks.

•

IN THIS ISSUE

GLASS is no longer to be considered solely as a fragile substance. In the hands of the industry's technical men it has become also an engineering and construction material. Recent developments indicate that its future use will exceed even the wildest imaginings of the glassmakers of a generation ago. A cross section of today's glass industry is presented by Robert G. Skerrett.

•

IF THEY were not controlled, insects might conceivably destroy virtually every growing plant and shrub. As it is, they take a great toll. The chemist has shown us how to kill the pests that feed upon processed foods and many other commodities that man consumes or uses. An accepted method is treating them with poison gas, effectively administered after practically all the contained air has been evacuated. Details of the process are given in an article by John M. Baer.

•

THE lining of tunnels with concrete is of comparatively recent origin. Great advances in the technique of placing such linings have been made during the past 25 years. These improvements are discussed by Robert S. Mayo, who has served as construction engineer on numerous large-scale operations of this sort.

Compressed Air Magazine

Volume 42 **JULY, 1937** Number 7

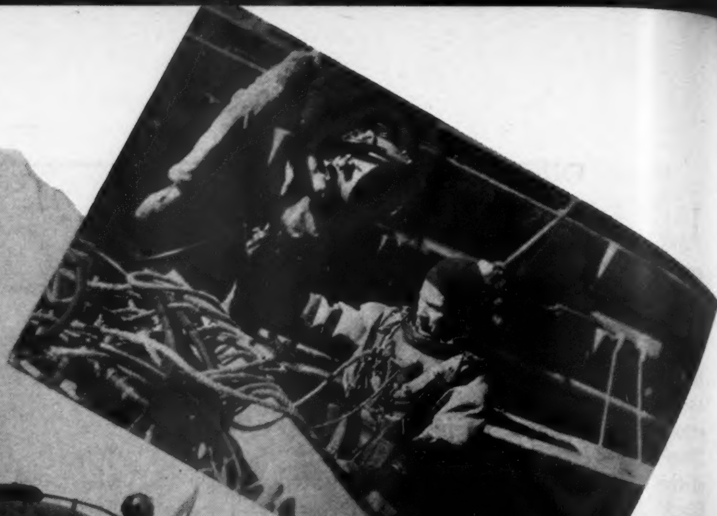
C. H. VIVIAN, *Editor*
J. W. YOUNG, *Advertising Manager*
A. M. HOFFMANN, *Assistant Editor*
J. F. KENNEY, *Business Manager*
D. Y. MARSHALL, *European Correspondent*, 243 Upper Thames St., London, E. C. 4
F. A. McLEAN, *Canadian Correspondent*, New Birks Bldg., Montreal, Quebec.

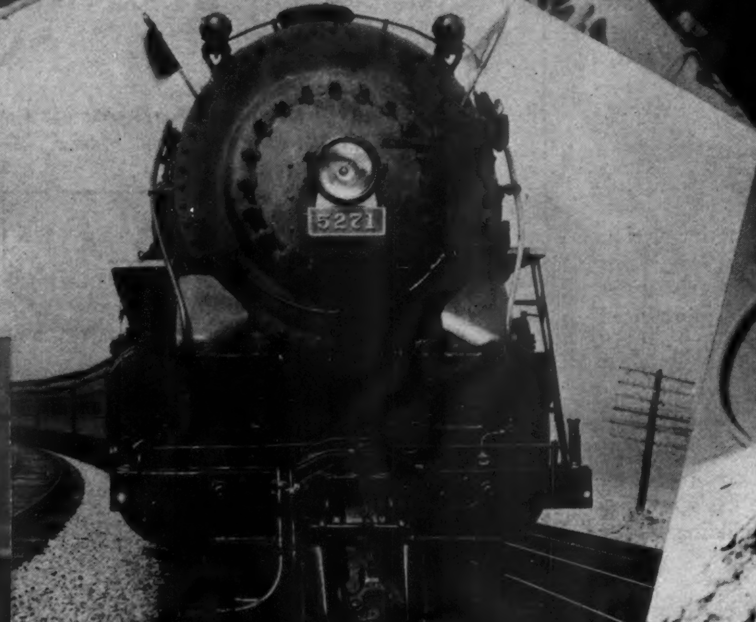
EDITORIAL CONTENTS

ADVERTISING INDEX

A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

Published by Compressed Air Magazine Company. G. W. MORRISON, president; R. A. LUNDELL, vice-president; F. E. KUTZ, secretary-treasurer.
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York, N. Y.
Annual subscription price: domestic, $3.00; foreign, $3.50. Single copies, 35 cents.
Compressed Air Magazine is on file in many libraries and is indexed in Industrial Arts Index.





AIR!

When the train slows up as the brakes take hold,
That's Air!
When rock dust gleams with a streak of gold,
That's Air!
When a sluggish giant is roused from sleep
At a turn of the valve, as the drill bites deep,
And the ore lies there in a glittering heap,
That's Air!

Oh jam a breeze in a steel bound tank
Till the gauge is all aquiver;
Then drive a tunnel from bank to bank
Beneath some boiling river!
When a thousand demons mutter low,
And sand-hogs laugh in the muck below,
With faith in the power of the thing they know,
That's Air!

When a stream leaps out from an oily sump,
That's Air!
When sheave wheels creak where the pit cars dump,
That's Air!
Wherever the work of the world is done,
'Neath sullen sky or broiling sun,
And T-beams sing to the riveting gun,
That's Air!

—*Carey Holbrook*

Our Oldest Industry Goes Amazingly Modern

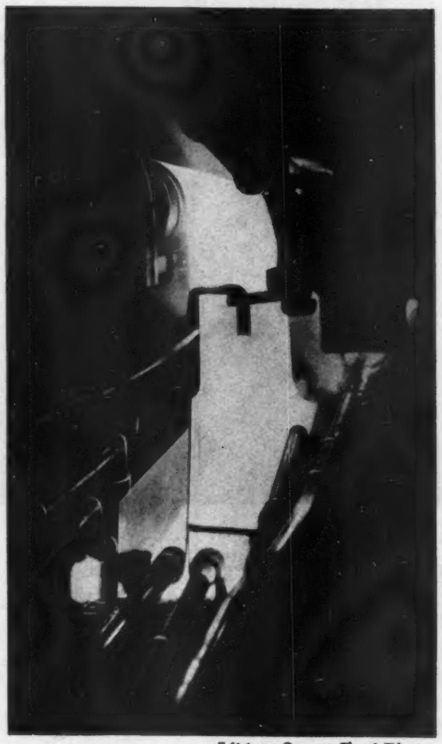
Robert G. Skerrett

THREE decades young: more than three centuries old! Contradictory, yes; but, even so, a true summary of the long record of glass making in America.

Our glass industry, great as it has become, lagged for generations behind many of our other departments of manufacture. Today, the industry is a remade and tremendously invigorated one and holds an outstanding position among our essential industries. It has reached its present stature and promise of still larger growth principally because of the latter-day joint efforts of the engineer, the chemist, and the physicist, working hand in hand first to achieve manifestly needed betterments and then to obtain results formerly undreamed of or deemed unattainable.

The collaboration of these technicists has brought about a veritable revolution in the understanding of what glass actually is; in the industrial art of glass making; in the knowledge of the reactions that take place in the pot or the tank during the melting of the ingredients; and, finally, the ways in which the molten material can be made fit for ever-widening services. In short, glass has ceased to have the physical limitations accepted as inevitable for hundreds of years. It has acquired a new significance in both our daily and our industrial life, and can be definitely given valuable characteristics that glass previously did not possess. The chemist and the physicist are working wonders with glass much as the metallurgist has transformed the steel of the past by employing modifying alloys and heat-treating processes. The newer glasses can be adapted to meet a broad range of variable and exacting conditions. Batches of glass can be produced day in and day out that will have certain prescribed characteristics.

America's first manufactory was a glass plant erected outside of Jamestown, Va., in 1608. Its purpose was to make bottles, but subsequently crude window glass and beads were produced—the latter for bar-



Libbey-Owens-Ford Photo

BIRTH OF A PANE OF GLASS

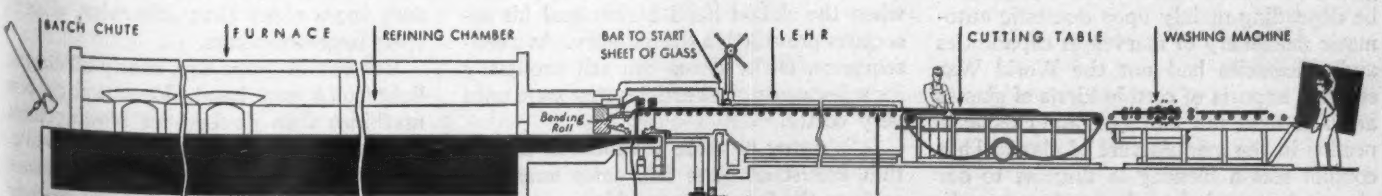
A sheet of plastic glass being drawn upward from a forehearth and bent over a roller to start its journey through a long annealing furnace or lehr, after which it will be cut into sections of marketable size.

tering with the Indians. Despite that early start, glass making failed to maintain its lead as the country developed; and in numerous respects we trailed behind Europe in the quality of many of our glasses up to less than three decades ago, although the volume of our output kept pace with the market demand. Why our glass industry was in a chaotic state even after the beginning of the present century has in part been thus explained by R. L. Frink, one of America's leading glass technicists, in a paper read by him in 1909:

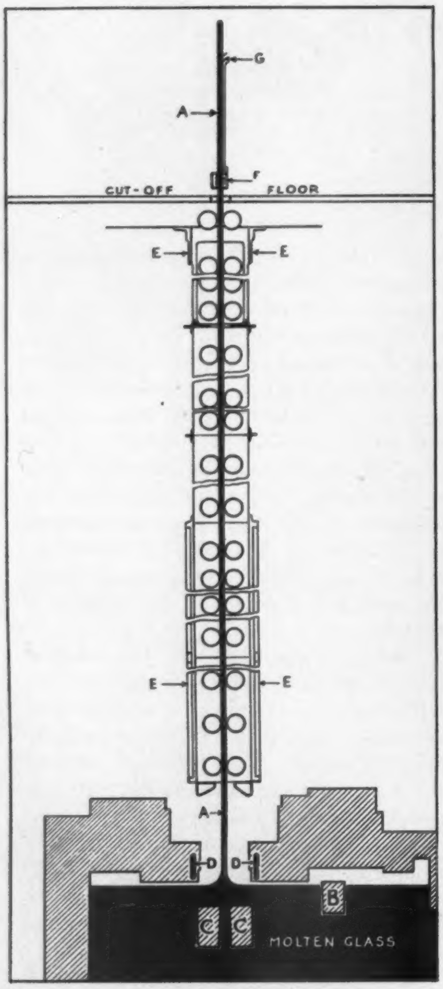
"I found that glass making today is carried on with no regard to definite proportions or consistent methods of operation; that it is void of any true knowledge; and is essentially an industry based and operated upon and subservient to personal opinions and prejudice, poisoned by legendary ideas and jealousies, and made generally unwholesome by lack of progressiveness or any initiative on the part of those who might, if they would, arise from this quagmire and put themselves on a basis of scientific fact."

Even in 1916, when the Government made an extensive survey of our glass industry, but few chemists were allied with the industry, and only the large companies employed them. The average manufacturer's chemical knowledge of the materials entering into glass making was very vague. That was astonishing in view of the importance of the industry and the inescapable fact that glass in its making is the result of chemical reactions in the presence of high temperatures. Indeed, the majority of glass makers at that time gave little if any heed to the chemistry of glass or to the chemical purity and careful proportioning of the ingredients forming the batch. Instead, to lower costs and to improve their products in some directions they turned more and more to machinery to supplant the handworker who had dominated the making of glass for four or more thousands of years. But, as the Government investigators emphasized, "the most perfect machine is absolutely useless with bad glass or glass of excessive cost."

Today, the ingredients of the better glasses, at least, must satisfy precise specifications for purity; the composition of a given glass is proportioned with exactness; and the temperatures during melting, refining, and processing are successively subject to very nice regulation and control. Guesswork and hit-and-miss methods are



SCHEMATIC DIAGRAM OF HORIZONTAL PROCESS OF DRAWING FLAT GLASS



VERTICAL DRAWING

Window glass and some thicknesses of plate glass are drawn in this manner by the Pittsburgh Plate Glass Company. *A-A*, the sheet of glass; *B*, skim bar; *C-C*, draw bar; *D-D*, water coolers to chill the sheet; *E-E*, machine case; *F*, cut-off wire; *G*, edge cut-off; *O-O*, asbestos-covered rolls.

no longer tolerated. The engineer, the chemist, and the physicist are now in command. The physicist is no less important than the chemist, because he is essentially responsible for the ultimate properties of any given glass that make that material useful in practical service.

The foregoing picture of our glass industry is painted not to disparage but to show by contrast how far it has now progressed. America's glass makers might still be depending mainly upon domestic automatic machinery of marvelous capabilities and efficiencies had not the World War stopped imports of certain kinds of glasses and also some raw materials and chemicals needed in the manufacture of glass. That conflict was a blessing in disguise to our glass industry: it forced us to become self-sufficient in producing essential chemicals and in discovering domestic sources of indispensable raw materials. Incidentally, those trying years encouraged the habit of carefully looking into the purity and fitness of all ingredients of a glass batch; and it led us to delve into the technology of glass and glass making as we had not done before. Resulting researches were responsible for unexpected and valuable original discoveries; and those revelations blazed the way to the commercial development of novel and worth-while glasses and to marked improvements in long-familiar commodities. Today, as a consequence, American glasses of all kinds are fully equal to corresponding foreign products; and in a number of sorts and forms of glass we stand supreme.

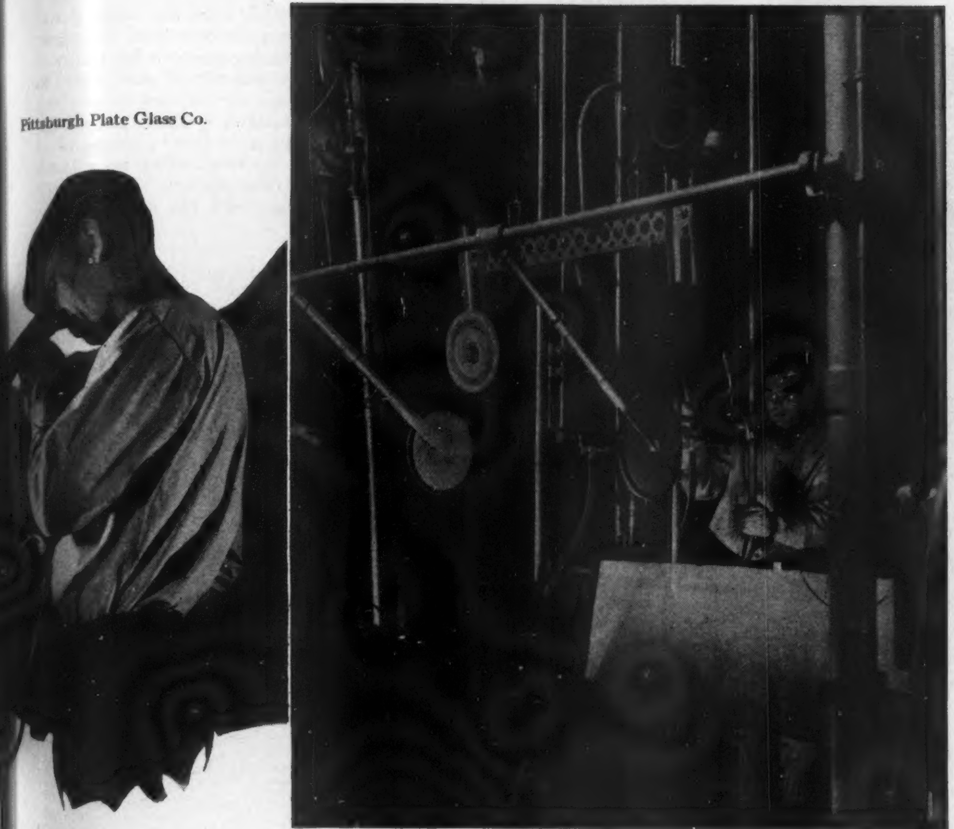
Taking it by and large, glass making in this country is now a well-balanced industry. Questionable formulae—long held as family or company secrets—have been scrapped. Precision and positive knowledge are the order of the day; fuel, for generations used wastefully, is now made to render much more efficient service; and modern plant management contributes to substantially lower costs of production. Machines are in service that do faster and continuously better work than was possible when the skilled hand blower and his associates prevailed in the industry. As a consequence, chain stores can sell profitably for a few cents glass articles that were once very costly.

It is owing to these advances in the art that industrial glass has come conspicuously to the fore of late, and its many-sided virtues and desirable characteristics have opened to such glass wide fields of adaptation. Industrial glass represents a continually increasing percentage of the total annual output. By industrial glass is meant those kinds and forms of glass that have their primary applications in architecture, in construction, in plant equipment, in commercial products, in the distribution and marketing of materials and commodities, in the chemical industries, in the laboratory, in different fields of engineering, and in other employments not immediately associated with the ultimate consumer, although he may be the one finally benefited.

Probably nothing will indicate economically how far we have advanced in the last 30-odd years than a few official figures. In 1899, our 355 glassworks turned out products valued at $56,539,712. In 1935—the latest year for which statistics are available, 213 reporting plants manufactured glass and glassware having a total value at the source of substantially $284,000,000. Within the same span the glass plants, themselves, became truly factory structures and not the flimsy cheap housings of the past; and instead of shifting frequently to be near the source of the lowest priced fuel, they became fixtures where more permanent conditions justified their establishment and, more often than otherwise, close to their largest markets.

But twelve years ago, nearly all electric light bulbs were hand blown, and the few machines then devised for blowing them were able to make only 32 bulbs a minute. Today, the big and apparently cumbersome machines in use can each turn out as many as 400 bulbs a minute, and they do their work better and with astonishing uniformity in the product. Such a machine will

Pittsburgh Plate Glass Co.



DRAWING FLAT GLASS

Flat glass was once made by splitting cylinders and subsequently straightening the curved sections. It is now made by continuous drawing processes. Shown here are steps in the vertical method. The view on the opposite page shows an operator guiding the "bait" to start its upward journey between the rolls. The "bait" is an agglomeration of molten glass caught up on an iron bar that is lowered into the melting tank. The glass passes upward some 30 feet, meanwhile being drawn into a flat sheet of the exact thickness desired. The picture just to the left shows a sheet rising through the cut-off floor above the rollers. The discs are vacuum cups which grip heavy glass on both sides, thereby eliminating the necessity for handling it manually. When the sheet has risen the desired distance above the floor, electric wires heat it along a horizontal line, the operator touches the heated edge with a cold iron bar, and the glass fractures along the heated line. One of the modern means of observing the temperature of molten glass is the optical pyrometer. The inspector shown in the center is using this instrument to check the temperature of the melt used in drawing flat glass.

utilize 50 tons of glass in a full working day; and it is practicable to run it continuously for 48 hours before any adjustment is needed. Machines now blow radio tubes and many sorts of miniature electric bulbs. To assure success in this department of manufacture, the chemist has modified the glass to make it rapidly workable in a machine, and the physicist has, in his turn, done his part to assure a finished product that has increased sturdiness and more effective diffusion of the filament's glow.

In the fairly recent past, the finest polished plate glass, the best of mirrors, and a large percentage of the higher grades of window glass were imported. Gradually, mechanical means for producing plate glass and polishing it and machines for blowing window glass were devised and adopted in the United States. Twenty years ago much domestic window glass was hand-blown by skilled men who produced cylinders that were then split lengthwise and flattened into sheets by placing them in suitable furnaces. The machines used at that time blew successively lengthening vertical cylinders 4 feet in diameter and up to an ultimate length of fully 30 feet. Those cylinders were then split lengthwise after they had been cut up circumferentially into a number of units 5 feet or so in length. That glass was superior generally to the hand-blown variety and could be made thicker and better suited for the glazing of large windows. While few if any of such machines are now employed, they served to point the way to the continuous method of drawing glass in wide and long sheets, either horizontally or vertically, as now practiced in the most modernly equipped window glass plants. Window glass of the conventional single strength and double strength is thus manufactured—the thicker sheet being drawn at a slower rate than the thinner one.

The continuous method of drawing flat glass for windows has been adapted to the drawing of plate glass of ample thickness for a great many services. The Libbey-Owens-Ford method is used in drawing the sheet horizontally, while the Pittsburgh Plate Glass Company draws its window glass and certain thicknesses of plate glass vertically. Briefly, in each case, a "bait" or horizontal bar of iron is lowered into the molten glass at the refining chamber end of a large rectangular tank holding from 1,000 to 1,500 tons of the incandescent fluid, and when that bar is lifted over or between rolls it draws with it a clinging sheet of glowing glass that quickly passes from the fluid to the plastic and then to the rigid state. In a Libbey-Owens-Ford plant, the plastic sheet, after following over a bending roll, passes through a 200-foot annealing chamber from which it issues ceaselessly on to a table where it is cut into large sheets and then passed through a washing machine. Each large sheet is subsequently cut into the customary marketable sizes.

By the vertical drawing process, the sheet of glass, 90 inches wide, is drawn continuously upward between a succession of encased twin rolls, slowly and steadily for a distance of 30 feet to a slot in the cut-off floor; and then, when the top of the sheet has reached the prescribed height, electric wires near the floor heat the sheet along a horizontal line, the operator touches the heated edge with a cold iron rod, and the glass fractures from side to side along that line. In this manner, sheet after sheet is detached. By either of the drawing processes described, window glass of a marked uniformity and of a high quality can be produced that could not be duplicated by the hand-blown or the mechanically blown methods. Plate glass so manufactured is of a quality that makes it acceptable for uses where only plate glass cast on a table and afterwards ground and polished would formerly have satisfied the specifications. This plate glass is now used in increasing quantities for automobiles and other conveyances, for glazing, for office, shop, and interior partitions, for store fronts and interior fittings, for furniture, and so forth.

The heavier polished plate glass, some of which is as much as 1½ inches in thickness and in large sheets, is extensively used in the making of the costliest of mirrors. It is made by the pot-casting method which provides rough sheets of 250 square feet, maximum, that are then ground and polished on each surface—reducing the original thickness by one-third to one-half. The present-day method of pot-casting and finishing cuts down the handling during grinding and polishing from six operations to two; and contributary processes have speeded up the work—incidentally materially lowering the cost of production while subscribing to the highest standards. This has extended the use of such glass in this country; and we no longer have to import glass of this kind. In keeping with the modern demand for a wide use of color,

GLASS HOUSES THAT WILL RESIST STONES

Hollow glass building blocks are suitable alike for business and factory buildings and admit of pleasing architectural treatment. The large building (center) is the packaging research laboratory of Owens-Illinois Glass Company. It contains 80,000 glass blocks in exterior and interior walls. The interior view shows the drafting room, where ample light is always available without glare. The view at the left shows structural features of Ownes-Illinois Glass blocks. The young lady is pointing to the longitudinal seam where the two halves were joined together. The same surface has been specially finished to insure a good bond with the mortar that is used in laying the blocks.

Owens-Illinois Glass Co.

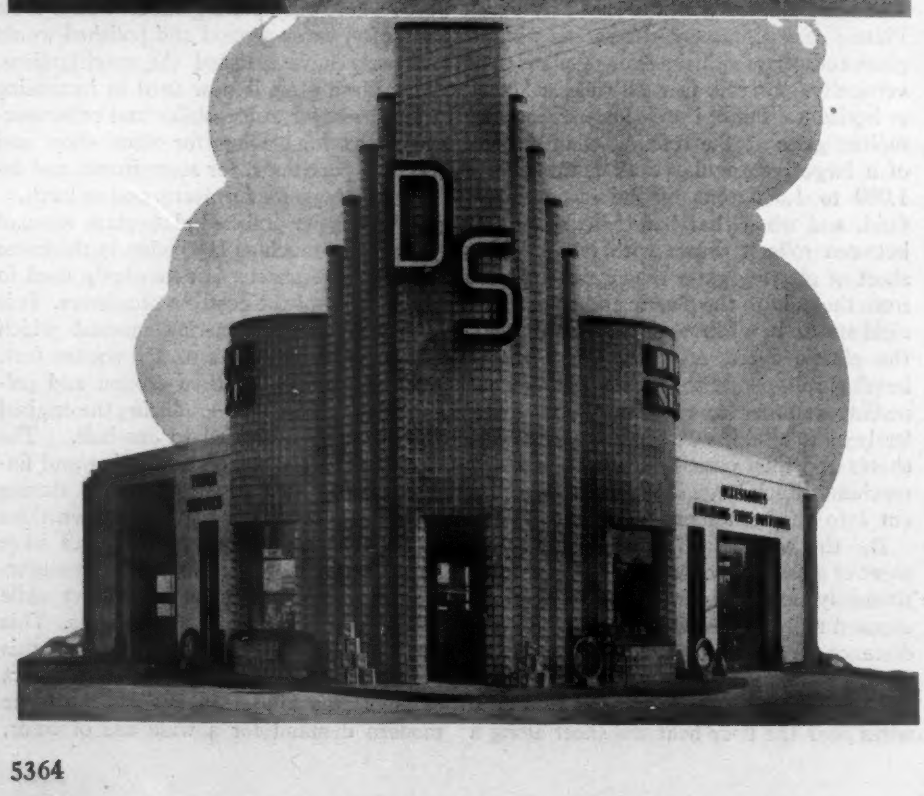


plate glass for mirrors is now manufactured in America in tones of blue, peach, and green—adding just that much more to the materials available to the architect and the interior decorator. The aforementioned window and plate glasses are all transparent; but there are other forms of thick glass that are variously designated as polished wire glass, polished figured wire glass, polished figured glass, and plain figured glass.

Wire glasses and figured glasses are intended to admit daylight and, therefore, are translucent but not usually transparent. The wiring of the glass is primarily to prevent shattering and to afford greater protection than ordinary glass when exposed to fire. Wire glass has, in consequence, played a conspicuous part in fire protection and is extensively employed in buildings of almost all kinds. Wired or figured glasses are now so patterned as to admit and diffuse a greater percentage of daylight.

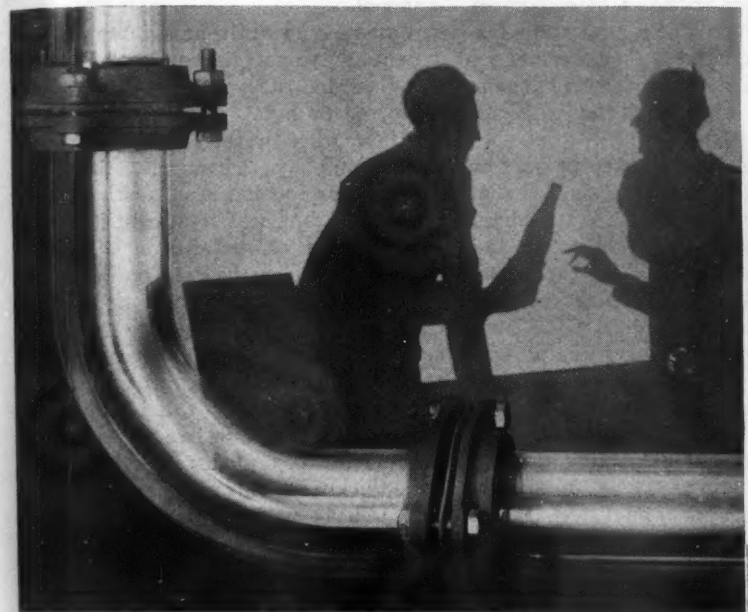
By diffusing the light properly, glare can be reduced and illumination increased. Mechanical aids are now available for the embedding of the protecting wire mesh in wire glass and for impressing the improved patterns on figured glass. Glasses of this class are now available for manufacturing plants and for other buildings either for the glazing of windows, transoms, skylights, or for the paneling of interior subdivisions; and immense quantities of them are so used.

The industrial use of bottles is historic; and for a great while was mainly restricted to the wine and liquor trade and to the

A HAT AND A BAG OF GLASS

Articles knitted of yarn made from glass fibers possess a luster that is so dear to feminine hearts. Delicate and beautiful colors, ease of cleansing, and serviceability are other virtues that may popularize this modern textile.

Owens-Illinois Glass Co.



Corning Glass Works

The Pfaudler Company

GLASS FOR HANDLING FLUIDS

Glass tubing and glass-lined receptacles are widely used in various industries to meet the needs of absolute cleanliness, freedom from contamination, or resistance to acids or other corrosive materials. The truck tanks are insulated, and each transports 1,500 gallons of pre-cooled milk long distances and holds it at low temperatures. The tubing shown is made of Pyrex heat-resisting glass. It can readily be disconnected for cleaning.

makers of soft drinks in subsequent generations; but in later times glass containers became increasingly popular for the bottling of patent or proprietary medicines and, still later on, for the packaging and sale of pharmaceutical and toilet preparations of endless sorts. Perhaps the greatest impetus to the glass-container business resulted from the use of bottles and jars for the distribution and sale of foodstuffs, thus fostering the visual appeal made by showing the buyer just what he was going to get. This very effective marketing practice was made possible by the perfecting of fully automatic bottle-making machines capable of being used to turn out bottles, jars, jelly tumblers, etc., at an unprecedentedly rapid rate and in a wide range of sizes. The output of a single bottle-making machine exceeds that formerly attained by 40 skilled handworkers. The glass containers produced in 1935 had a total value of $124,492,570; and by far the major part of them was used by packers of foodstuffs, beverages, and medicinal and toilet preparations. Indeed, the glass-container branch of the industry leads by a long way the other departments of the industry in the number and value of its products.

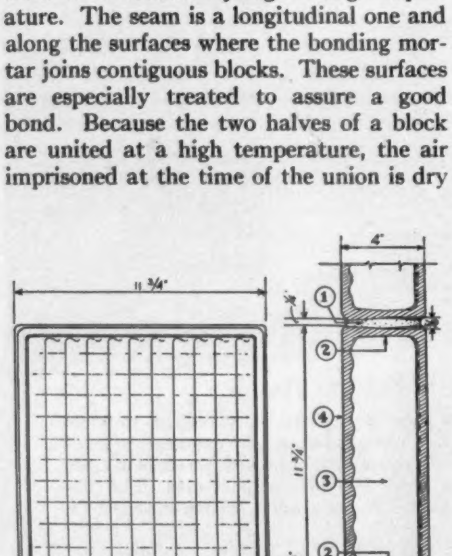
So far we have described long-familiar commodities that have been brought up to date in manufacture and in their characteristics; but the scientists of the glass industry have done of late astonishing things that are of great present and potential value. Probably the most significant among these are the hollow glass building blocks devised and developed, respectively, by the Owens-Illinois Glass Company and the Corning Glass Works. These blocks represent years of research and the mastering, one by one, of technical and manufacturing difficulties. Again, the engineer, the chemist, and the physicist have collaborated successfully; and the hollow glass block is now accepted by the architect, the underwriter, the American Society for Testing Materials, and by the duly constituted building authorities of the various cities. The object of the hollow glass building block was not to produce just one more structural material and to amplify the output of the glass industry, but the major aim was to utilize glass in a way to take full advantage of certain of its distinctive characteristics and to make available structural units having unique and undeniable merits. These are the capabilities of transmitting and diffusing daylight, of serving as an insulating medium, of reducing the admission of external noises, of offering resistance to fire, of possessing ample strength for structural use, and, withal, of being easily cleaned and readily replaced when damaged.

Either of the American hollow glass structural units or blocks is made of a glass of a very low coefficient of expansion. In the case of the Corning block this figure is .0000018 inch for each degree of temperature change between 66° and 662°F., and is, therefore, lower than that of most metals and other structural materials. In each case, the glass is purposely translucent instead of transparent, and the two internal surfaces that are parallel with the outside and inside surfaces of the wall, are so ribbed or patterned as to reduce spottiness or glare

while transmitting a large percentage of the outside light. The measure of transmitted light is controlled by the formation and arrangement of the diffusing internal ribs or prismatic patterning, and by actual test this figure may be as high as 78 to 88.3 per cent of the received light. On the other hand, the transmitted light may be intentionally reduced to only 12 per cent if low-light intensity be desirable for any reason. In short, the light-transmission factor can be modified to suit the different exposures of the walls of the building.

The Corning block is made of borosilicate heat-resisting glass of the kind used in manufacturing the well-known Pyrex ovenware and the still more recent top-of-stove ware which can be directly exposed to a high-temperature flame while being used for cooking. The Owens-Illinois block is made from a kindred type of glass. Borosilicate glasses are used extensively in industries and plants where conditions are such that metals and other materials could not long withstand exposure, continual wear, and attack of acids. These facts explain why they have been selected for the making of hollow glass blocks.

Each block is made up of two shallow rectangular pans, the exposed lips of which are brought together under pressure and united at a sufficiently high fusing temperature. The seam is a longitudinal one and along the surfaces where the bonding mortar joins contiguous blocks. These surfaces are especially treated to assure a good bond. Because the two halves of a block are united at a high temperature, the air imprisoned at the time of the union is dry



CORNING GLASS BLOCKS

Pysical features of an individual block and, at the right, of an assembled wall section. 1—Portland cement mortar, 1:1:6 mix. 2—Glass seal. 3—Partial vacuum. 4—Average thickness, 7/16 inch. 5—1/16x1½x11-inch metal reinforcing strip every third or fourth joint.

and rarified, and the resultant partial vacuum increases the insulating factor of the block while the dry air effectually prevents any fogging of the block through condensation when the enveloping atmosphere is chilled or cold. The hollow glass block is meeting with widespread favor, and is now being used in many types of structures. Walls made of it provide superior illumination by daylight and make it easier to keep a building warm in winter and cool in summer, especially when equipped with air-conditioning facilities.

The same two glass companies placed on the market fibrous glass and showed that even textiles could be made of glass fibers. In principle, fibrous glass is not new, but American ingenuity has developed mechanical means that make it practicable to manufacture glass fibers on a large commercial scale and possessing characteristics heretofore unattainable. The glass filaments can be formed from the molten material in different diameters, and it is said that filaments of only one-tenth the size of a human hair can be produced having the tensile strength of mild steel. In the form of fluffy bats, the fibrous glass is especially effective as a sound absorbent and as a heat insulator. A third valuable use consists of a criss-cross arrangement of larger filaments to serve as filtering pads for the intakes of air compressors, internal-combustion engines, air-conditioning equipment, and other kindred applications. The felted fine and soft fibers, because of their vitreous nature, are not subject to decay, are fireproof, are unaffected by moisture, and are capable of resisting the attack of most acids.

At the present time, fully 50 textile companies are experimenting with fiber glass in making various fabrics. Already fiber-glass tapes have been woven that have outstanding dielectric strength; and for electric insulation they compare favorably with rubber and varnished cambric in established use. During the initial stages of this adaptation of glass filaments to textile making, the fabrics woven tended to irritate delicate skins. The cause was discovered, and recent improvements have overcome this drawback. Yarns have been spun of pleasing colors and both woven and knitted into attractive fabrics and articles. Glass fabrics may presently be employed for draperies wherever fireproofing is desired; and the possible applications of glass textiles are well-nigh limitless.

Safety glass, two or more sheets of thin glass bound together by a transparent resin or cement, has been in use for some years for automobile windshields because the glass, even when cracked or shattered by a blow, does not scatter in the form of sharp and menacing pieces. This form of laminated glass is today produced in thicknesses from ⅛ inch to 2 inches; and the latter, composed of from three to five combined sheets, is said to be resistant at close range to the bullets of the heaviest of side arms and high-powered rifles. The sheets of clear glass are brought together by pressure while heated, and between the plates are films of transparent cement which serve as a binder. All these glasses have various and many uses from glazing the windows of an aircraft to shielding bank offices from the demands of the armed criminal.

Probably one of the most interesting and potentially valuable recent products of the flat-glass industry is what is known as tempered or heat-strengthened glass, put on the market by the Libbey-Owens-Ford Glass Company. Chemically, the glass is of the same composition as the familiar plate glass, but heat treatment imparts to it additional characteristics. Tempered glass results from heating ordinary plate glass until it is well-nigh plastic, and then cooling it suddenly by exposing the external surfaces to blasts of air. This cooling chills the outer layers, causes contraction and induces compression of the interior mass. Glass so tempered is five times stronger than a sheet of ordinary plate glass of the same thickness. This new glass can be bent cold well beyond the breaking point of other glass; it can be twisted to a marked degree without fracturing; it is notably resistant to sudden and extreme changes of temperature; and when it does break under severe strain it simply crumbles into innumerable small pieces that are free from the sharp and jagged edges of the usual glass. A sheet of tempered glass ½-inch thick has borne, under test, the weight of a 3-ton elephant. This glass, in different colors, may be used for making furniture and for allied services; and already it has been adapted to the glazing of port holes in ships, deadlights in kitchen ranges, port holes in furnaces, and for shelving required to sustain heavy loads.

Glasses are available today which, because of their chemical and physical properties, are capable of filtering out the heat rays from sunlight or any other source while permitting the passage of most of the light rays. Glass of this kind can be counted upon to add to the comfort of persons within a building where the maximum of daylight is desired in the summertime, for example. Again, a one-way glass has been evolved that prevents the blinding glare of approaching headlights without seriously impairing the vision of the driver. Architectural glasses have latterly been made available to take the place of polished stone for the exterior trim of buildings; and ornamental cast or pressed glass is now to be had in many forms for the interior finishing of buildings and for the artistic and pleasing diffusion of hidden sources of light.

Myriads of clear glass spheres, each .015-inch in diameter, form the basis of what is known as the Refract-o-lite system of marking traffic lanes in place of the paints commonly employed. The glittering tiny granules are secured to the road surface by a binder compound that may be of any color. The spheres reflect impinging light, and the stripe is thus made 2,000 times as

bright as a simple painted stripe of a given color. Although the binder used to grip the glass spheres is effective even when applied as a much thinner coat than the run of marking paints, still the granules are held firmly in place and have been found by abrasive tests to remain unharmed where paint alone would suffer greatly. Furthermore, the glass granules are not affected by the ultraviolet rays of the sun, which are the principal cause of the breakdown of the usual paints.

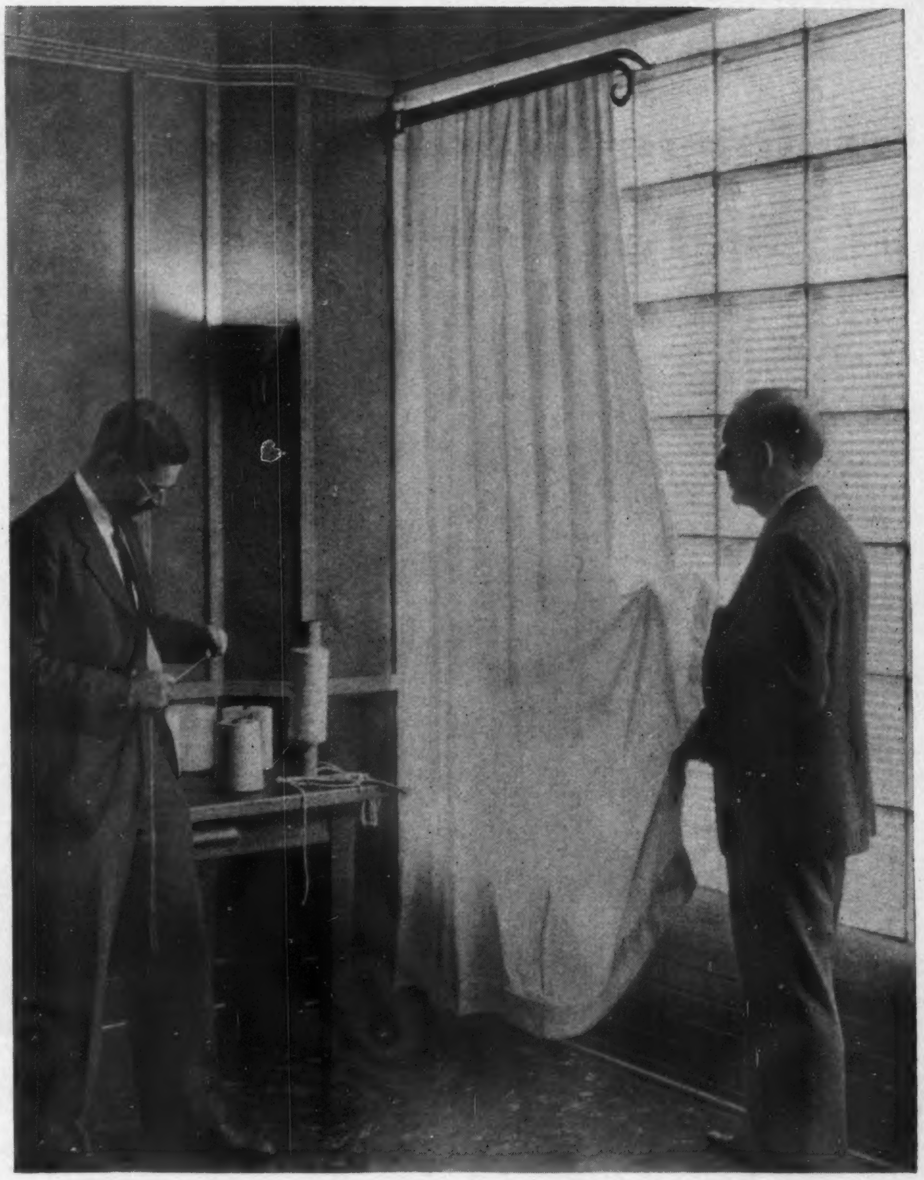
One of the newest uses of glass is for the ceiling of the Midtown Hudson Tunnel, New York City, which when finished will consist of two tubes. In the longer tube, the ceiling will be made up of 800,000 molded glass units or tiles, and in the shorter tube of 600,000 similar tiles. Each tile weighs 15 ounces before it is assembled in its bronze gripper, which adds 6 ounces to the unit weight. These tiles are being embedded in the concrete slabs of the ceiling so that their outer surfaces form a glazed area designed to diffuse reflected light and to minimize objectionable glare. Those ceilings will be easy to clean and to keep in a desirable condition.

In the large pharmaceutical laboratories that contribute to our well-being, in sugar refineries, in chocolate plants, in breweries, in plants where extracts are made, and in those establishments that are engaged in turning out food products—not to mention milk condensaries and milk distributors, glass-lined reaction kettles, stills, condensers, mixers, evaporating pans, storage tanks, etc., are now commonly used. The glass lining protects the commodities undergoing processing from undesirable reactions or deterioration from the direct contact with the metal of the vessels. For kindred reasons glass tubing is supplanting metal tubing in many industrial directions. Tubing can now be had from the smallest sizes required for thermometers up to 12 inches in diameter. The use of glass pipe renders it possible to see what is going on from one end to the other of the production line and thus to make that system "one continuous test tube." The present-day steadily widening employment of glass piping in industry awaited the development of a suitable type of joint. This is now available in the form of a coupling or joint based upon the gland principle of assembly.

We can only mention the fact that insulators for telegraph, telephone, and power transmission lines are made of glass; and two years ago those products had a value of substantially $2,332,500. These insulators are by no means as simple as they look, and they represent today the outcome of much research by the different contributive technicists. There is an absorbing story in our position in the field of optical glass, but we can here only hint at it. It is gratifying to know that since 1914 our producers of optical glass have freed us of any dependence upon foreign sources of supply and are able to furnish us with glasses of unquestioned excellence for all sorts of services. Optical glass is used not only for photography, for picture projecting, for telescopes, for field glasses, for fire-control apparatus for the Navy and the Army, but for many kinds of technical and scientific instruments required in research and in making routine examinations and tests in innumerable branches of our complex industrial life.

Until latter years few railroads were equipped with semaphore lenses of standardized colors. The reds, the greens, and the yellows of different railroads varied in their hues and visible characteristics, and under some atmospheric conditions certain of the colors were misleading and were responsible for accidents. Today, thanks to the physicist, the distinctive signals on all of our railroads are uniform and to be depended upon at all times; and the same technicist, by redesigning the lamp lenses, was able to double the distance at which a signal could be seen.

Color in glass is one of the most difficult things the glass technologist is called upon to produce and to control nicely during the stages of manufacture. Probably what has been attained in this particular in the making of glass in America indicates in a striking manner how far we have gone forward in the last twenty years. Nothing is now left to chance; precision is the order of the day; ingredients have to meet definite requirements; the batch is proportioned to a nicety; temperatures are regulated at every step by thermostatic apparatus; and a highly developed technique is opening the way for far wider, more diversified, and more helpful uses of glass in industrial services. Glass no longer has its traditional limitations; it is a modernized material of tremendous potentialities.



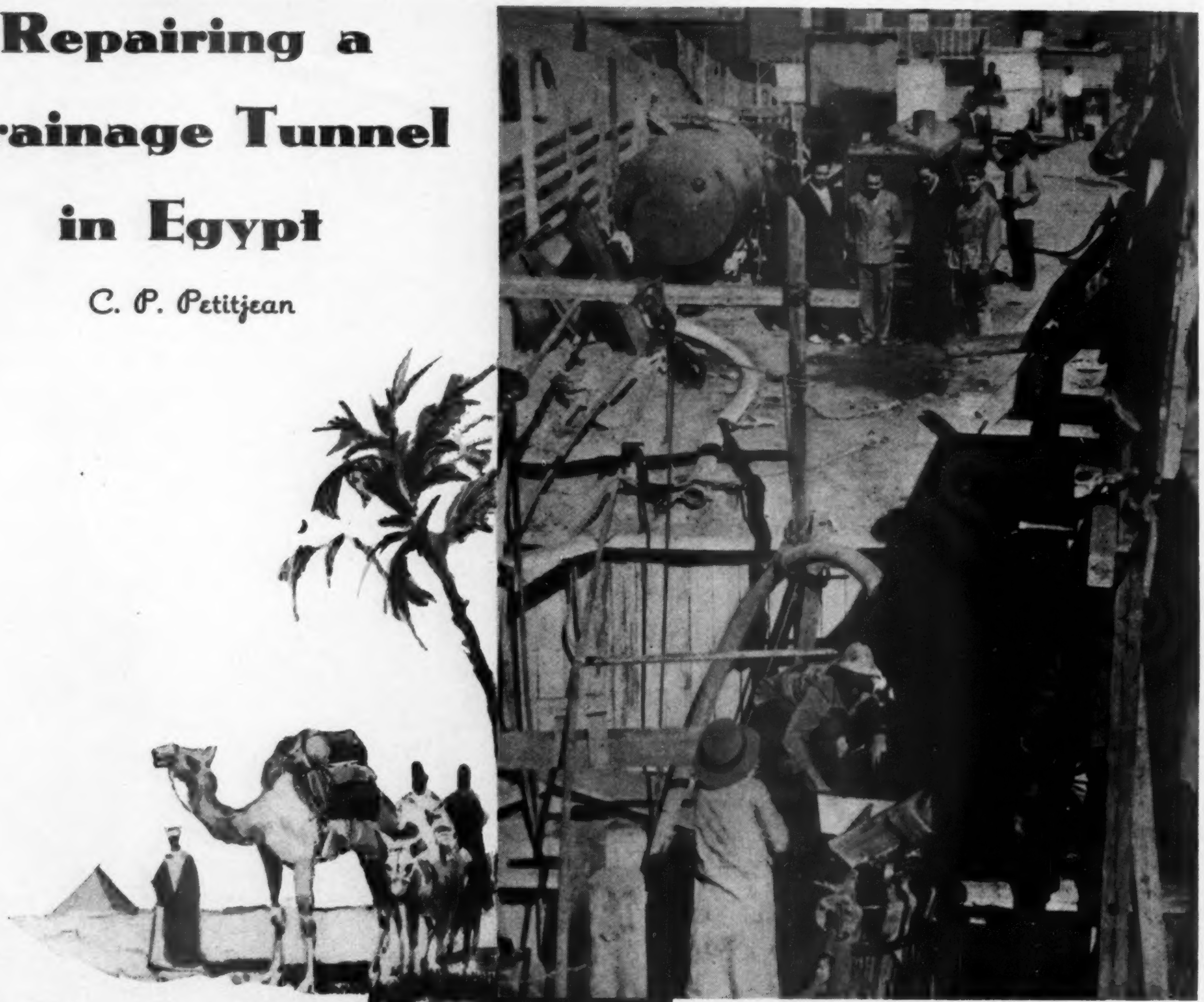
Corning Glass Works

DRAPERIES OF GLASS

Technologists of the Corning Glass Works examining a curtain of glass hanging in front of a wall of Pyrex glass building blocks. Glass draperies have the valuable attribute of being fireproof. On the table is some of the yarn from which the cloth was woven. The wall at the right is made up of hollow glass building blocks.

Repairing a Drainage Tunnel in Egypt

C. P. Petitjean



EQUIPMENT AT A SHAFT

In the foreground is the filling hopper of one of the "Johny" concrete conveyors. It is being filled with concrete through a wooden trough leading to it from the right. At the top is one of two portable compressors that furnished air for moving the concrete from the "Johny" into the forms in the tunnel below. The large volume of air required at a time was obtained by using the large storage receiver shown at the upper left.

THE DRAINAGE system of Cairo, Egypt, embodies a main collector tunnel that collects the material from the sewers and delivers it to a sewage pumping station at Kafr Faruk. The collector is constructed of concrete and lies at a depth below the surface that varies from 15 to 25 feet. On the outside its walls and bottom are straight and the top is arched. The interior is circular in section and 5 feet 2 inches in diameter. The minimum wall thickness at the sides and bottom is 18 inches and at the top it is 14 inches. The collector has a fall of only one foot in 2,500 feet. Access to it is provided by manholes that are spaced from 200 to 1,000 feet, and even 1,200 feet, apart.

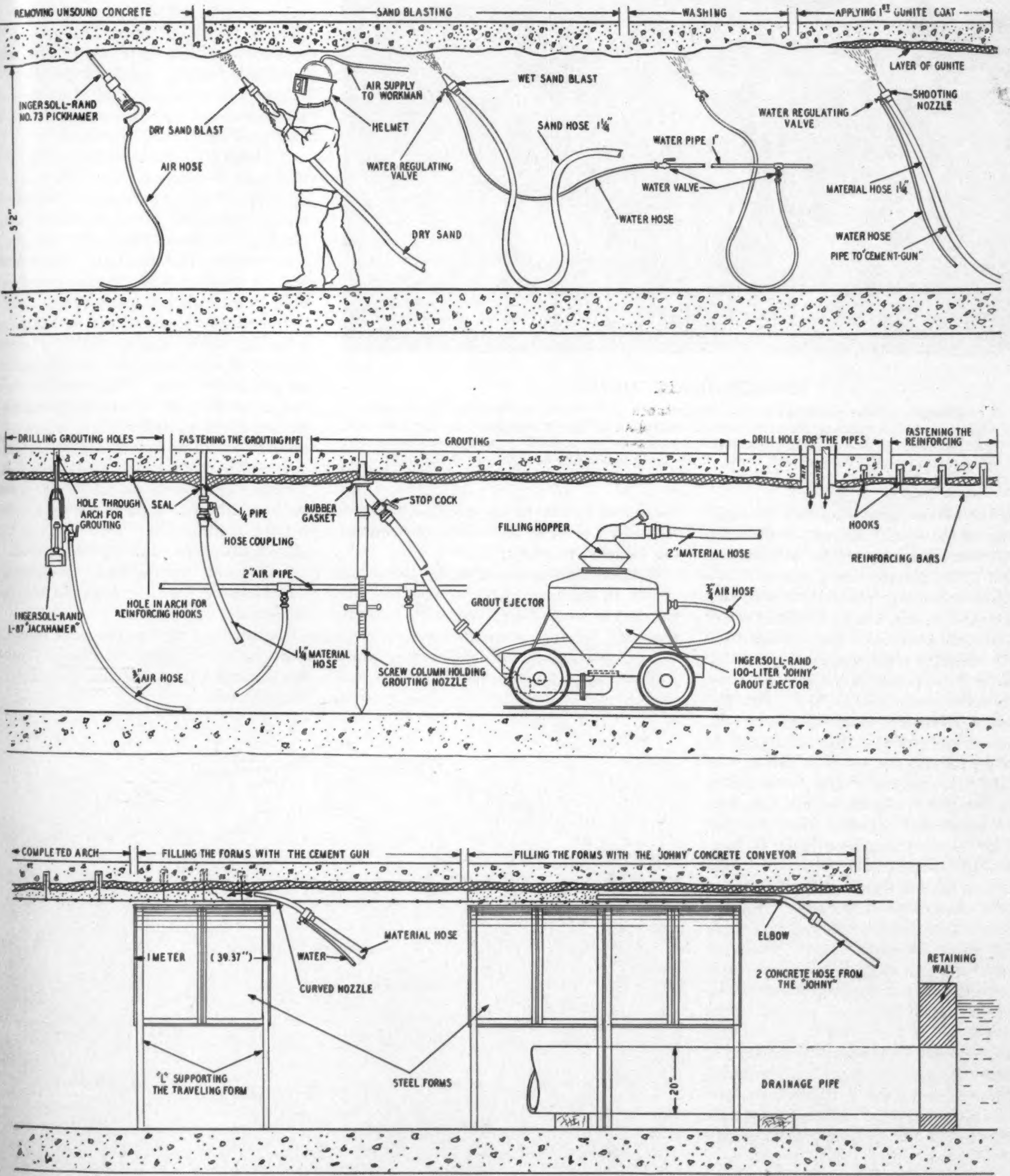
The water level in the conduit is generally not higher than the center of the section, and the lower portion of the interior that has been continually covered seems to be in good condition after years of service. The upper, or arch, portion of the tunnel, on the contrary, has been attacked by corrosive vapors rising from the sewage carried. Examination disclosed that the disintegration of the concrete had proceeded to a point that made reinforcement necessary, and that work has recently been carried out.

It was obviously desirable to use as a relining material something that would resist so far as possible the destructive action of the sewage fumes. After a thorough investigation had been conducted, it was decided to employ reinforced "Gunite," as this gave promise of best meeting the requirements. A contract was accordingly let by the Ministry of Public Works of Egypt to Messrs. Fils Barthe Dejean & Company for the reparation of the collector over a distance of 7,760 meters (about 25,500 feet).

Many difficult problems had to be solved in connection with the execution of the work. The first of these was the provision of means for handling the sewage without interfering with the placing of the lining. This was met by repairing short sections at a time and by segregating the portion of the tunnel being worked on by erecting bulkheads or retaining walls at either end. A 20-inch pipe was laid on the floor to convey the sewage while repairs were underway. This permitted pumping out the enclosed section so that the work could be carried on in the dry.

The second obstacle pertained to the restricted space in the tunnel and the difficulty of transporting materials and equipment over comparatively long distances. However, careful advance planning of the work and thorough organization of the forces, enabled the contractors to carry on the operations rapidly and without delays. The extensive use of pneumatic tools and other air-operated equipment made it possible to reduce the required number of workmen in the crowded space to a point that confusion was avoided.

The sequence of operations by which the repairs were made is shown in the accompanying sectional schematic drawings. The first step was the removal of the disintegrated concrete with an Ingersoll-Rand No. 73 "Pickhamer." This was followed by sand blasting and washing the exposed arch surface. These operations revealed the thickness of the new lining that had to be



PICTORIAL STORY OF THE WORK

These sketches show successive steps in the operations on a typical section of the collector. They indicate how the work was organized so that the entire course of treatment could be carried on in an orderly manner and consequently at a good rate of speed despite the small section of the tube. It will be noted that compressed air was used at virtually every stage of the work.

SOURCE OF AIR SUPPLY

Compressed air was essential to the performance of virtually every operation connected with this relining contract, and to insure an adequate supply of it, the contractors used the five 2-stage, air-cooled, oil-engine-driven portable compressors shown lined up near one of the points of work. Note the camels in the background at the right.

applied and determined whether a "Gunite" coating would suffice to restore the original section or if it would be necessary to build it up by placing new concrete.

It was frequently found that the arch had become so affected as to admit water into the collector from the outside, and in such cases the picking operation was followed by the application of a coat of "Gunite" in order to seal off the flow. The next operation consisted of grouting the old, porous concrete of the arch to strengthen it. Holes for this purpose were drilled with an L-87 "Jackhamer," and immediately before the grout was introduced, the contained water was expelled from the concrete by blowing a strong blast of compressed air through it by means of a pipe inserted in each of these holes. The grouting was done with a portable "Johny" pneumatic grouting machine having a capacity of about 3½ cubic yards. The grout consisted of a thin mixture of cement, sand, and water, and was applied through a 1¼-inch hose under 30 to 40 pounds of air pressure.

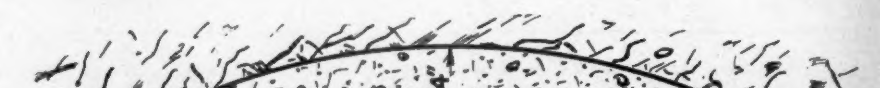
The arch was then ready to receive the concrete lining, if such was required. This was placed behind Blaw-Knox steel forms which rested on rails on either side of the collector. These rails both supported the forms in the proper position and also facilitated moving them from one concreting location to another.

Reinforcing bars were set by the means shown in the accompanying sketches, and the forms were then filled with concrete from a "Johny" pneumatic concrete conveyor. Mixing of the ingredients, which included aggregates of ½-inch gravel, was effected in the conveyor by blowing compressed air into the hopper. The mixture was delivered into the forms through a 2-inch hose at the discharge end of which was affixed a length of steel pipe. This extended inside the forms at the top, and by gradually withdrawing it, it was possible to fill at one operation two or three sections, each one meter long. Despite the cramped working conditions and the numerous obstacles that had to be overcome, the rate of concrete placement was as high as 2 to 3 cubic yards per hour.

To insure complete filling of the forms, and a dense concrete, vibration was adopted. This was carried out with light pneumatic hammers, a round-headed tool replacing the usual chisel for striking the steel work. The result of this vibration was to produce smooth, even surfaces of the concrete when the forms were removed.

In order to expedite the undertaking as a whole, work was carried on simultaneously in several parts of the collector, each section under repair being reached through one or more shafts. As compressed air was employed in virtually every stage of the operations, an adequate supply was essential, and to insure this, five Ingersoll-Rand 2-stage, air-cooled, portable compressors, each of 210 cfm. capacity, were employed by the contractors. Two "Johny" concrete conveyors and injectors, two N-1 cement guns, and several "Jackhamers," "Pickhamers," etc., completed the list of equipment.

During its progress, the work was supervised for the Ministry of Public Works by the General Director of the Main Drainage Department.



CROSS SECTION OF TUNNEL

Examination disclosed that the concrete had been weakened only in the upper half of the collector. Repairs were made by chipping out the disintegrated section, grouting the remaining portion of the arch, applying a coating of gunite, and then shooting new concrete into place behind steel forms to restore the original thickness of the arch. To provide additional strength, reinforcing bars were set as indicated.

Cleaning Oil Sands with Hot Air

J. R. Cozzens

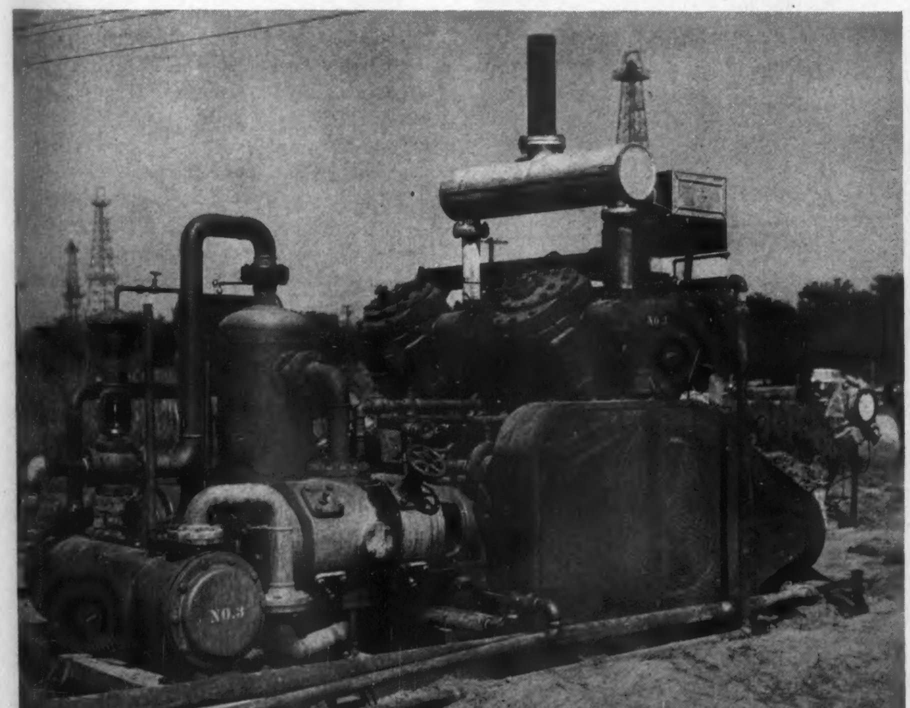
CLEANING oil sands by air pressure is a modern process that is producing splendid results in the shallow-sand fields of southern Ohio. These were among the first fields in America to use compressed air for the purpose of forcing oil through conglomerate sands, and as is invariably the case where continuous pumping is done, sand channels gradually filled with paraffin and other residue until wells could no longer be operated at a profit. To remedy this condition, operators tried burning the sand face with light charges of nitroglycerin, introducing salt water, gas, steam, etc., but these and similar measures gave only temporary relief.

About that time, certain operators had discovered that air, heated under compression, was a practical means of melting paraffin and sludge from surface lines and tanks. This led to the conclusion that heated air might likewise clean underground oil channels, provided it could be introduced at the proper temperature. The advent of 85 per cent magnesia and similar insulating pipe coverings made the process a reality in a crude way. Other improvements in temperature control, between 1930 and 1935, further reduced installation costs, until to-day, with insulated pipe made for the purpose, the modern operator applies hot air to oil sands 2,000 feet underground at a temperature wastage of less than 5°F., and the air compressor over a period of days does a job that other agencies failed to do in twenty years.

When a producing well reaches the stripper stage, and before natural rock pressure is entirely exhausted, the modern operator obtains a rubber packer, one-half inch smaller than the inside diameter of the casing. Pumping equipment is removed from the well, and down the casing is pushed the packer, connected to a 20-foot section of 2-inch insulated pipe. Other sections of pipe are added until the packer is forced to its destination at the bottom of the casing, and just above the oil sand. Three to six feet of loose earth, asbestos fiber, or sawdust is poured down the casing around the pipe so as to prevent warping and consequent loosening of the casing collars from excessive heat. The upper end of the insulated pipe is then connected with a gas-engine-direct-driven air compressor. Light compressors are best suited for this purpose, especially when less than three wells are to be treated together, and preferred types are of twin-cylinder design, ranging from 150- to 200-hp. in size. After connections are made, air heated under compression to a temperature of 300°F. is forced down the hole. Compression is usually continued for from 48 to 70 hours, or until the air pressure in the pipe at the casing head registers 800 to 1,000 pounds. At this point, the compressor is stopped, and air is released through a valve in the casing head. The sudden release of air stimulates natural rock pressure which has been forced far back in the sand, and the outrush brings with it into the well reservoir barrels of melted paraffin, wax, and sludge. This residue is promptly removed by a suction bailer, after which air of the same pressure and temperature is applied again for the same length of time. Further improvement in rock pressure is noticed with the second release of air pressure, but in most cases a third, and even a fourth intermittent treatment is necessary to restore a well to normal producing volume. In more than 80 per cent of the wells thus treated, oil production has been increased by from 30 to 50 per cent, and the oil shows a better gravity test, demonstrating that sand channels in the vicinity of the well bottoms are free of damaging residue. The duration of increased production depends of course upon the depth and condition of the sand, but in the majority of cases, months and even years may elapse before further air treatments are required.

Sand cleaning by compressed air can be done on the average lease at a cost of $50 per well. There is practically no waste of power, because once the channels are cleaned, air pressure can be applied in the regular way for forcing oil through the sand. In very shallow wells (300 to 800 feet), excellent sand-cleaning results are being obtained by using 2-stage portable air compressors. In districts where natural gas is available in sufficient quantities, air compressors are put in service for forcing gas through the oil sands following the hot-air cleaning. In certain other districts, mineral water is forced into the sand by compressed air.

In practically every case of modern sand-cleaning, the air compressor is a vital necessity. Proper control of compressed air now makes it possible to treat oil-producing sands at any depth; and in almost all the fields there is a rising margin of profit owing to increased efficiency and lowered operating costs.



COMPRESSOR FOR OIL-FIELD SERVICE

A 150-hp. gas-engine-driven compressor that has been mounted on steel skids to facilitate moving it from place to place. This is an Ingersoll-Rand Type XVG unit which has four power cylinders, arranged in two V's, and two horizontal compression cylinders. Machines of this design are available in four sizes, from 75 to 300 horsepower, and for discharge pressures up to 2,000 pounds per square inch. They are suitable for the service mentioned in the accompanying article, for flowing wells by air-lift or gas-lift, and for various other applications in oil fields and refineries.

Vacuum Fumigation for Insect-Pest Control

John M. Baer

TREATING GOODS OF VARIOUS KINDS

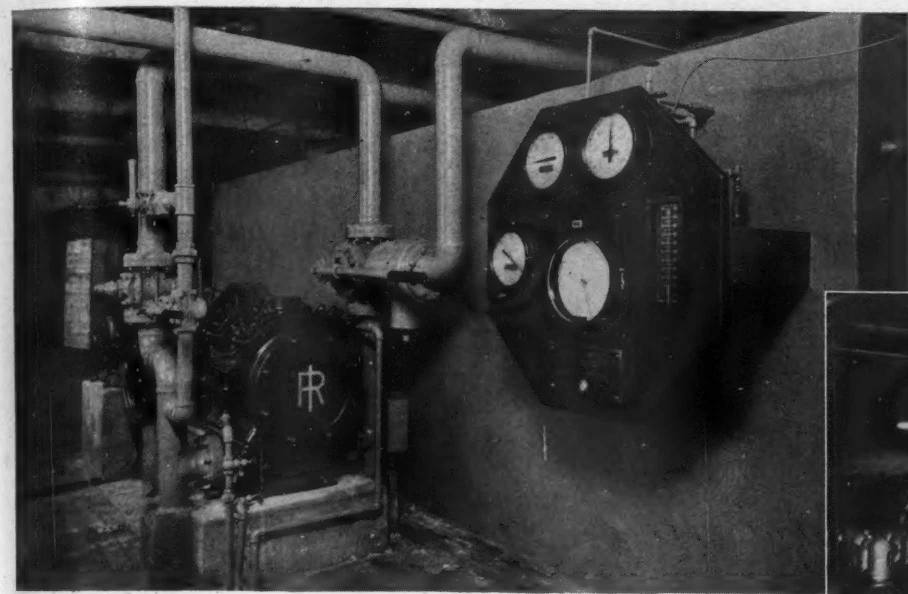
One of the advantages of the vacuum process of fumigation is that it can be successfully applied to packaged materials. Just above, boxed cigars are shown entering a treatment chamber and, in the center, boxed and bagged cereals are stacked inside a vault. For most materials, a vessel of rectangular section will provide maximum capacity, but one of round section is suitable for handling barreled goods, as is illustrated at the top. As these pictures show, materials may be loaded on trucks or skids, or may be placed on the floor of the chamber, depending upon plant conditions. In two of the views the accumulator tank from which the gas is admitted into the treatment vault is shown on top of the chambers.

INSECT pests take as heavy a toll from America as the tax collector. No one knows exactly what the goods and property losses are, but they range well up into the billions of dollars per year. Until lately, there has been available no method for the control of such losses that was both economical and convenient for industry. But makers of chemicals and skilled designing engineers have together developed effective processes and materials for that purpose.

It has long been known that a great many chemicals could be used for industrial fumigation. But some of these were highly toxic to man as well as to insects, and others involved dangers of fire or explosion. The application was accordingly greatly limited. Then there were developed certain new materials which were not subject to these incidental difficulties. Ethylene oxide, a synthetic chemical made from petroleum or natural gas, mixed with carbon dioxide, has proved to be one of the most advantageous of such materials. In fact, it is now one of the most widely used chemical fumigants, being marketed extensively under the name "Guardite" by the Guardite Corporation, of Chicago.

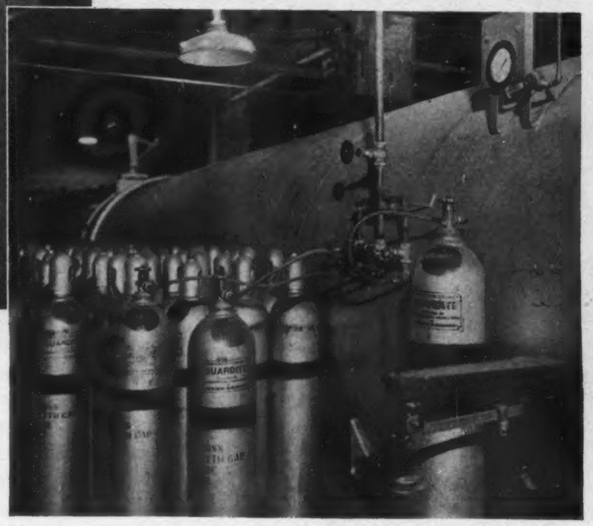
But the real advantages of Guardite gas would not be utilized to the full if this company had not developed its present technique for introducing exactly controlled quantities of this gas in such a way as to reach quickly and effectively every part of the material to be treated. It can well be understood that this was a real problem, for nothing is accomplished by fumigating only the surface of bags, barrels, or boxes of goods. The fumigant must reach the innermost parts of every container under conditions that are controllable. Only by such effective penetration is it possible to insure 100 per cent kill of the insects.

Much of the difficulty in securing pene-



VACUUM EQUIPMENT

If the fumigant is to penetrate to the center of baled, boxed, or sacked goods, it is essential that virtually all air be first exhausted from them. The accomplishment of this requires an effective, reliable vacuum pump. For all except small installations, reciprocating pumps are usually employed. One of them is shown here. It is driven by V-belts from an electric motor and is capable of pulling a vacuum of 29 or more inches of mercury.



CYLINDERS OF GAS

Guardite is shipped in high-pressure flasks of 60 pounds content. Two or more such flasks feed into a manifold which is connected with an accumulator tank. It is from the latter that the chemical, having been transformed from a liquid into a gas by the release of pressure, is introduced into the treatment chamber.

tration of fumigant gases into the center of a bale of tobacco or the middle of a bag of flour is caused by the slowness with which the gas will diffuse through the air which fills not only the space surrounding the package but all the interstices within the goods. Now that the new technique has been worked out, it seems absurdly simple. The Guardite process merely withdraws the air from the container in which the material to be treated is held and then allows the fumigant gas to fill the evacuated space.

Since practically all of the air is removed before the fumigant enters, this chemical almost instantly penetrates to the innermost parts of every container and the center of each mass of material. The effectiveness of the fumigant then depends solely on the relationship of concentration to temperature, as required for the lethal dosage of the pests. A relatively simple series of tests will disclose how much gas is needed, how long the goods must be exposed to this concentration, and what temperature limits it is advisable to set. With proper technique it is easy to guarantee a 100 per cent kill.

Food manufacturers and marketers have naturally been among the major users of Guardite fumigation methods and equipment. Foodstuffs, if infested, represent not only a loss of the goods, but also an inestimably large loss of prestige to the manufacturer. Mrs. Housekeeper who buys a certain brand of cereal and finds it infested does not repeat soon. The prestige value of fumigation may, therefore, be even greater than the goods-loss prevention factor.

Successful applications are, however, not limited to food. Tobacco and tobacco-products industries have found an invaluable aid in Guardite. With it, warehousemen protect a variety of goods, including fur coats, valuable rugs, and other furnishings subject to moth or beetle attack. Even Uncle Sam, in caring for his archives, finds Guardite fumigation of importance. One might almost say that the Constitution is literally preserved against attack by this means.

Equipment for vacuum fumigation is comparatively simple in form and operation. The treating space is essentially a cylindrical or rectangular chamber of a size appropriate for the goods to be fumigated. Mechanical facilities for loading and unloading by means of convenient trucks are arranged. Provision for heating the vacuum chamber and its contents is desirable.

Early equipment for vacuum fumigation utilized cylindrical treating tanks because of the simplicity of their construction; but more recent installations have employed rectangular tanks. Merchandise to be fumigated is usually best handled in a rectangular load on a four-wheel factory truck or skid. A load of this kind seldom utilizes more than half the available space in cylindrical vessels as against from 75 to 90 per cent in rectangular chambers. This not only increases throughput per unit of capital investment, but also minimizes consumption of fumigating gas per ton of goods treated.

Occasionally a special flooring, track, or rack holder is built into the vacuum chamber to accommodate the goods to be treated. With cylindrical chambers, a floor or track is always needed. For general fumigation uses in a plant processing a variety of goods, it is desirable, however, that these be accommodated on hand trucks or skids of standard size that fit the chamber. Thus any raw material or finished product may be processed in cases, cartons, barrels, bags, or other container most convenient for the particular material.

The chamber closure must be by means of vacuum-tight doors, preferably so counterbalanced as to be easily handled without accessory mechanical facilities. Doors may be provided at one or both ends of the chamber, depending on the material and the method of handling best suited to the individual plant being served.

For lowest installation cost, one-door chambers are employed; but two-door through-type units are preferred where untreated material is in one room and fumigated material should be discharged into another room. In this case the fumigating chamber has the partition wall placed around the body of the tank. This arrangement is especially desirable where there is danger of infestation traveling from the receiving room to the storage space or plant.

The fumigant gas is received in high-pressure cylinders from the chemical manufacturer, but it is not usually convenient to discharge the gas directly into the fumigating chamber. Preferably, therefore, the cylinders are arranged in multiple on a manifold, with proper gages, valves, and control facilities, ready for discharge into the accumulator, which is a small pressure tank built above the fumigating unit.

The accumulator should usually be of a size to hold, at 75 pounds pressure, at least enough fumigating gas for one-tank treat-

ment. The fumigant is released from the high-pressure cylinders into the accumulator, where it is vaporized with heating coils, if necessary, so that a homogeneous mixture will be ready at the proper temperature.

After being filled with goods the treating chamber is exhausted by means of a vacuum pump of such capacity and efficiency as to produce at least a 29-inch vacuum within 15 minutes. The type of pump used depends somewhat on the capacity of the chamber. A 2-stage reciprocating pump is preferred for all the larger sizes.

Suitable safety devices to control excess pressures and prevent other mechanical hazards have been developed. The equipment pictured in the accompanying illustrations has been critically studied by the Underwriters' Laboratories of Chicago. This impartial investigation insures that every reasonable and necessary means has been taken to prevent either fire or personal danger.

Operating cycles vary according to individual plant conditions. In general, however, they follow a simple plan. As soon as one batch of material has been finally treated and given its air-wash, the doors are opened and goods on the treating trucks are removed. A new charge is at once introduced and the doors are closed. The vacuum pump is started and the chamber exhausted to approximately a 29-inch vacuum. A precalculated dose of treating gas is introduced from the accumulator under the control of the operator and in accordance with pressure indications of gages on the operating panel.

After a prescribed interval of exposure to the gas, the fumigation is complete. The fumigant is then removed by the pump and the goods are given an air-wash by pressuring through the breaker valves and re-evacuation, with discharge of the rinsing air to waste. The chamber is then ready to be refilled with air and opened for removal of the goods.

The total time for such an operating cycle can be made shorter if the concentration of chemical used is increased. Usually, however, it is not economical to make the total period between one charge and the next less than 3½ to 4 hours. This affords approximately a 3-hour period for exposure of the material to the chemicals. With such an operating cycle of 4 hours, a single 9-hour shift accomplishes treatment of 3 batches per 24-hour day. Two normal 3-hour treatments are handled, followed by a third batch given a lower concentration of gas and allowed to remain in the treating chamber overnight.

This operating plan not only minimizes labor cost, but has the advantage of providing surplus treating capacity which can be used in peak-load periods by adding a second shift of workers. With a dual-chamber installation it provides fumigation for six charges per shift. Single-shift operation is uneconomical, however, if the quantity of goods to be treated at one point in a plant is so great as to require several complete operating units. Under those circumstances it is often better to operate two or three shifts per day, assuming that the other operations of the plant are so conducted, than it is to add a second or third complete fumigating outfit. In some plants fumigating chambers may be placed at various points in the works to take care of different materials. This saves rehandling or hauling of material excessive distances.

Chemical control of the process operation is not essential. Advance determination can be made of the quantity of gas to be used for each material being treated. Charts of calibration then indicate the quantities of gas which have been applied merely by reading the pressure indicating instruments.

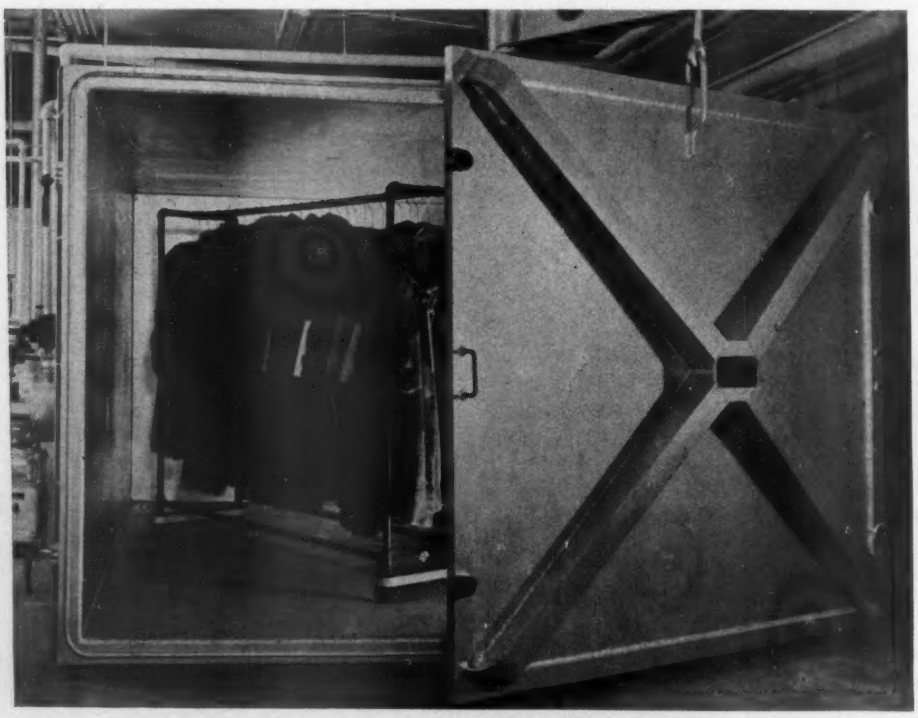
As a permanent file-record of operations, a 24-hour recording pressure-gage chart is made. Since the dosage for any particular kind of material can be determined in advance, such a pressure chart constitutes a permanent record of actual fumigation accomplished. Also it is a valuable record of the carefulness of operation by the attendants, facilitating management supervision of this work.

Effectiveness of fumigation for any particular insect in any particular goods varies with a variety of conditions. However, for all combinations the kill is quicker and more complete to the extent that the respiration of the insect is stimulated. Such stimulation may be achieved by lowered oxygen concentration, increased temperature, increased concentration of carbon dioxide, or any combination of these three factors. Vacuum processes have the advantage that they can both decrease the absolute concentration of oxygen and increase the ratio of carbon dioxide to oxygen, thus occasioning a double stimulation to the insect.

Following fumigation, goods may be stored more or less indefinitely without insect damage, assuming that they are protected against reinfestation. Only when the kill is complete is fumigation entirely satisfactory. Furthermore, the kill must be complete with respect to all stages of insect life, from egg through larva to adult. Usually this latter consideration is more important in determining the choice of the fumigant than in selection of the process; but it is also somewhat significant here because of the advantage of vacuum methods in reaching eggs and buried larvae.

Guardite is one part ethylene oxide and nine parts by weight of carbon dioxide. Ethylene oxide, which is a gas at ordinary temperatures, is definitely toxic to all forms of insect life when given in moderate dosage. It is mixed with carbon dioxide for several reasons. First, this eliminates all fire or explosion hazard, which would otherwise prevail, since ethylene oxide mixed with air in certain proportions is explosive. Secondly, carbon dioxide stimulates the respiration and hence the metabolic processes of the insect. This increases the toxicity of the mixture and makes smaller concentrations of ethylene oxide effectual.

Extensive experience with various types of goods using desirable fumigating gases shows that the vacuum process virtually precludes the possibility of any fumigant remaining in the goods. Apparently in no



SAFEGUARDING FURS

Storage of furs in refrigerated spaces minimizes insect damage, but does not in all cases completely eliminate it. As an added precaution, some storage places subject furs to vacuum fumigation before putting them away for the summer. In the case of tobacco, fumigation has in some instances supplanted cold storage.

case yet investigated has the question of residual fumigant been found in any sense a deterrent to this system of fumigation.

Packages of almost any shape or form may be treated by the vacuum process. Occasionally it is even necessary to treat packages that are almost hermetically sealed. In one case treatment of large closed tins of nutmeats was undertaken without removal of the slip-cover lids. Access to the interior by the gas was accomplished through a minute nail hole. Even with this limitation complete fumigation was feasible by the vacuum process; and, using a special technique, this was accomplished without an extension of the time of treatment beyond that normal for the same foodstuffs in containers more easily penetrated.

In only one instance, out of hundreds of types of food packages tested, has it been found that the closure of a package was so near to hermetic sealing that difficulty was experienced. In this one case a slight distortion of the shape of the package resulted when the evacuation or repressuring of the chamber was too rapid. Even supposedly tightly sealed food containers are not measurably so distorted in practice. Hence vacuum fumigation of foods in finished containers ready for shipment is entirely feasible in practically every case.

Most Guardite installations have been designed for factory use by the owners of the goods processed. But recently certain large merchandise warehouses have been equipped to serve small companies which do not require such equipment regularly or which cannot afford the necessary capital investment. Thus a custom fumigation service is available in New York, Philadelphia, and Chicago, with further installations in prospect.

The range of commodities treated, from candy to fur coats, is almost unbelievable. In some cases mold and bacteria control is also achieved with ethylene oxide, as for example with spices, where fungicidal and bactericidal action are just as important as insect control. In a few cases, the most important application has been in the fumigation of cartons and other packaging materials which may become infested and contaminate the best of factory products otherwise free from insect trouble.

Sometimes, especially in the cases of furs and tobacco products, this method of treatment is either a supplement to or a substitute for refrigeration. For example, fur-coat storage in a refrigerated space minimizes insect damage, but does not completely eliminate it. Fumigation before hanging of furs in a refrigerated space is, therefore, of great advantage to commercial warehouses, department stores, and furriers who do summer fur storage for many patrons. Fumigation of tobacco has in some cases actually supplanted cold storage, with great advantages even in long-time warehousing of raw materials.

PRESERVING GOVERNMENT RECORDS

This picture was taken in the Archives Bureau at Washington, D. C., where important papers and historic documents are regularly given a vacuum-fumigation treatment to preserve them from damage by insects.

The cost of Guardite fumigation varies somewhat with the type of goods treated, the character and size of the packages, and the total volume of material handled. The total normal operating cost ranges from 60 cents to 80 cents per ton of material processed. These figures are based on a plant so installed relative to other facilities for handling the material that the goods are readily loaded on treating trucks either from storage space, freight car, or production department, and that they can go from the fumigating department into storage or shipping without excessive rehandling. Costs per 100 pounds for typical commodities, including all charges except the labor of handling goods in and out of the treatment chamber are: cereals in bags, 2½c; cereals in cartons, 2¾c; dried beans in cartons, 1¾c; dried fruit in original boxes, 2½c; flour in bags or cartons, 2½c; grain in bags, 2¼c; shelled nuts, 2¼c; spices and condiments, 2½c; tobacco in bales or hogsheads, 5c.

The tabulation on this page shows the range of sizes of units commonly employed and the type and capacity of auxiliary facilities suitable for use with them. From the over-all dimensions indicated, it will be clear what floor space is needed; and from the weights it will be evident what floor loads must be provided for.

The cost of initial installation varies largely with the size of equipment and somewhat with local plant conditions. In a number of cases, half-carload units have been completed for less than $4,000. Units of 100 cubic feet capacity cost less than $2,000. The total investment usually ranges from these figures up to $10,000 for the largest unit commonly needed in food-plant operation. The largest installation yet built holds six standard railroad box cars per charge; but this unit would not often be of an economic size. In view of the fact that large tonnages can be handled per year by even the smaller unit equipment, the capital cost per ton of goods is usually only a small fraction of the operating expense.

In any event, the cost for fumigation of infested goods is a trifle in comparison with the losses that are likely to occur without treatment. Frequently, the increase in prestige and the improvement in customer relations are sufficient to make fumigation of either the raw material or the finished goods an economic necessity.

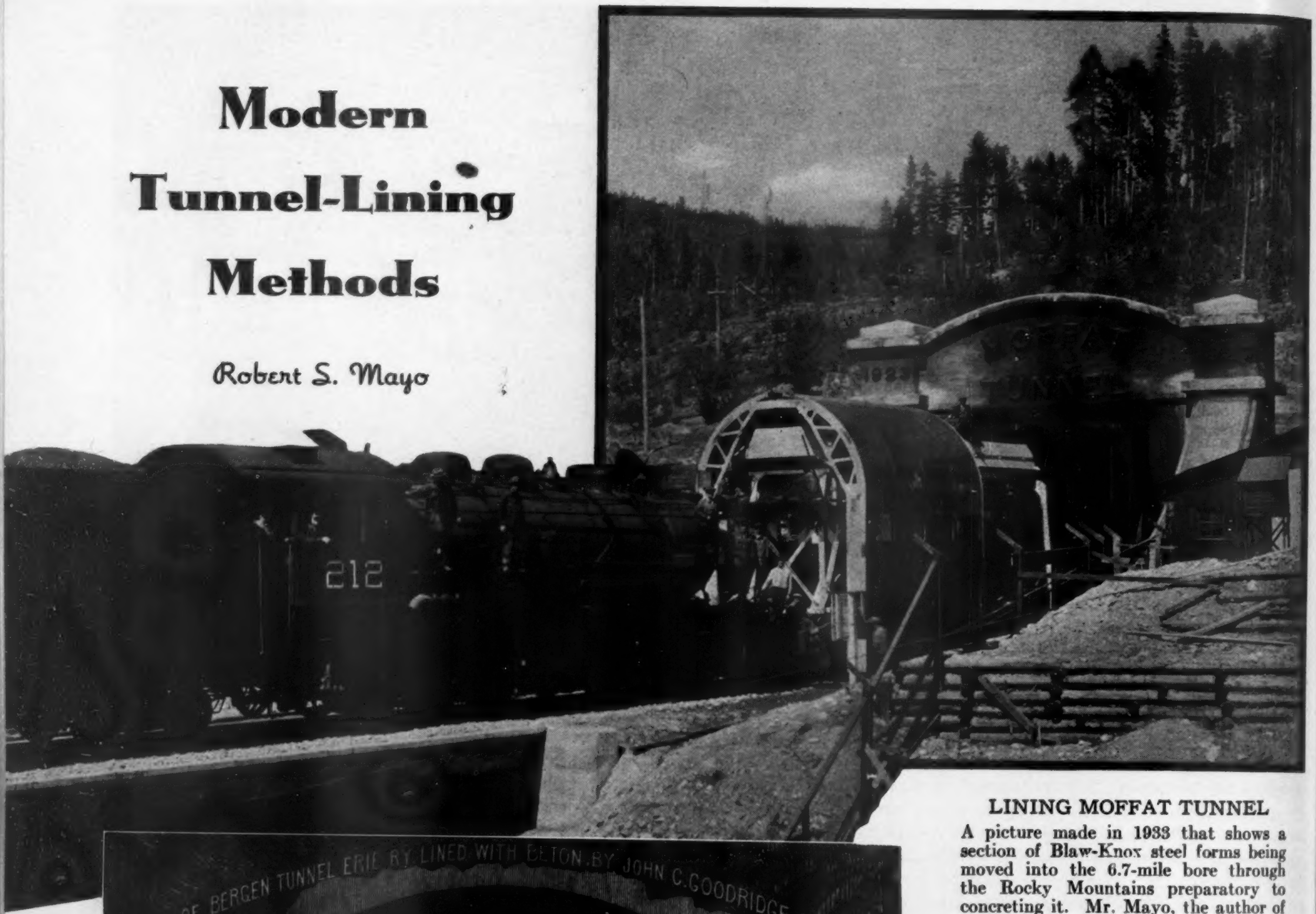
Capacity of Treating Units of Rectangular Section

	One-Half Carload	One-Carload Dual Unit	One-Carload Single Unit	Two-Carload Dual Unit
Size of treating tank*	6'6"x8'x26'	6'6"x8'x26'	6'6"x8'x52'	6'6"x8'x52'
Inside tank dimensions*	5'6"x7'x25'	5'6"x7'x25'	5'6"x7'x50'	5'6"x7'x50'
Vacuum pump, size	18x7	18x7	22x9	22x9
Motor (horsepower)	20	20	30	30
Accumulator (if vertical)	3'6"x9'	3'6"x9'	3'6"x9'	3'6"x9'
Accumulator (if horizontal)	2'6"x18'	2'6"x18'	2'6"x18'	2'6"x18'
Weight of tank (tons)	10	20	18	36
Weight of pump and motor (tons)	1.75	1.75	2.75	2.75
Weight of accumulator (tons)	1.12	1.12	1.12	1.12

*Over-all width by height by length.

Modern Tunnel-Lining Methods

Robert S. Mayo



LINING MOFFAT TUNNEL

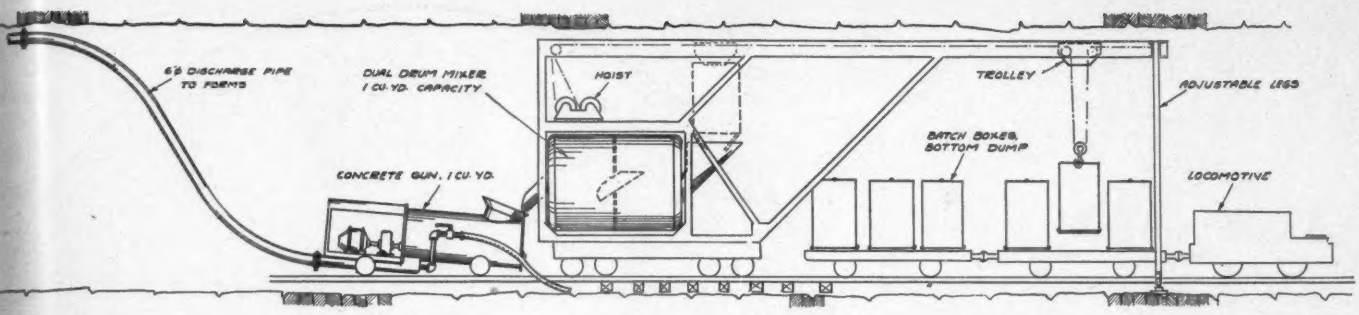
A picture made in 1933 that shows a section of Blaw-Knox steel forms being moved into the 6.7-mile bore through the Rocky Mountains preparatory to concreting it. Mr. Mayo, the author of this article, stands on the running board, with a hand on the locomotive cab. The tunnel is now a part of the Denver & Rio Grande Western Railroad system.

FIRST CONCRETE-LINED TUNNEL

This illustration is a reproduction of a wood cut that appeared in the Scientific American of May 8, 1880. It shows a portal of the Bergen Tunnel of the Erie Railway through the Palisades at Jersey City, N. J. Note the extra rail—the Erie track was of 6-foot gauge then. When driven, in 1855, the tunnel was supported at weak points by brick arches. Ground water coming down from above penetrated these and, in the winter time, formed huge icicles that had to be removed. In 1876, the bore was lined throughout with concrete, then known as "beton." The work was done by John C. Goodridge, Jr., of Brooklyn, who invented and patented the method used.

THE Bergen Tunnel of the Erie Railway, at Jersey City, N. J., was the first major railroad tunnel in America and the first to be concrete lined. The Erie originally ran from Piermont, N. Y., on the Hudson River about 25 miles above New York City, to Lake Erie. To eliminate the connecting boat trip between New York and Piermont, the line was extended down the Hackensack Valley and through the Palisades to the present Jersey City Terminal in 1855. The tunnel involved was 4,200 feet long and 28 feet wide by 21 feet high. It penetrated a very hard dolerite. All drilling was done by hand, and black powder was used for blasting. Muck was hand loaded and hauled to the dump by ponies. It took almost five years to drive this tunnel, the average monthly progress being 32 feet at each heading.

Modern tunnels of comparable size have been advanced at the rate of 1,500 feet in one month, for miners now use batteries of



CONCRETE MIXING AND PLACING OUTFIT FOR TUNNEL LINING

pneumatic drills which quickly put in a round of blasting holes. Furthermore, powerful explosives break the rock clean and small, electric fans and blowers rapidly displace the powder fumes and gases with fresh air from the outside, and special electric and compressed-air shovels load the broken rock into large muck cars which are pulled to a dump by electric locomotives.

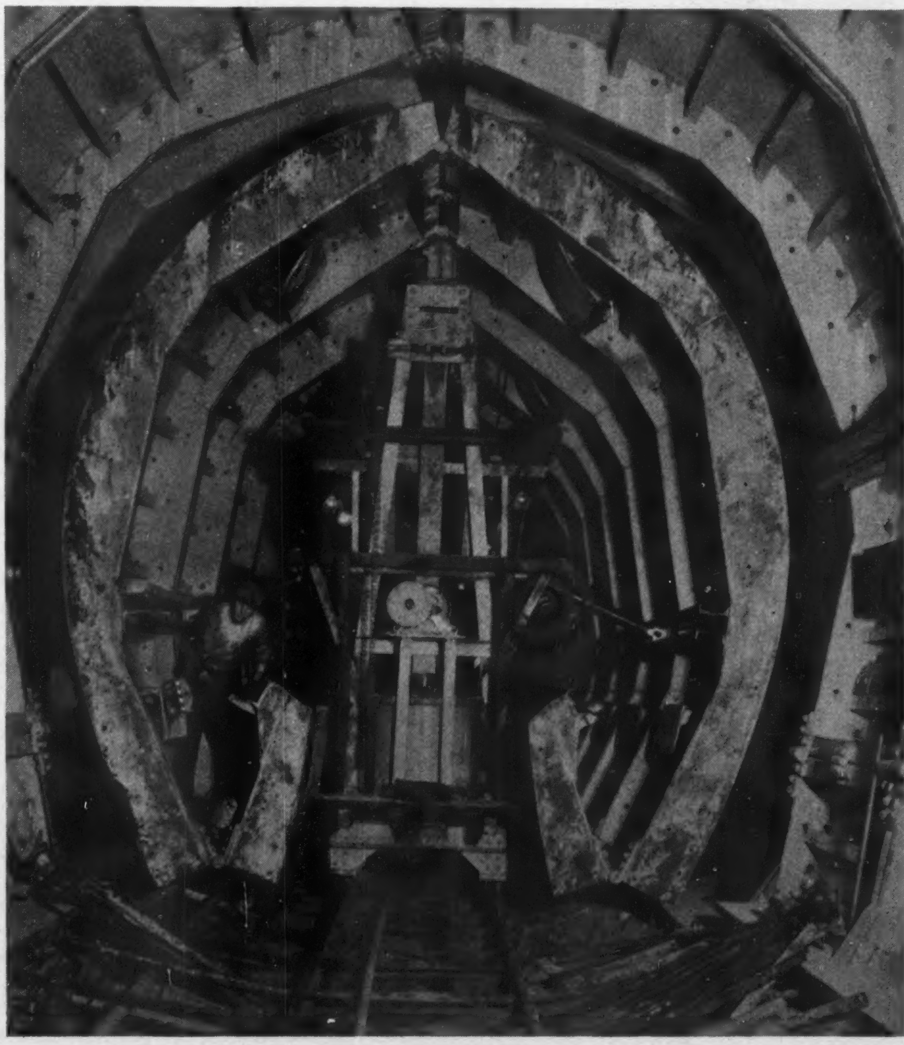
In the early days, most tunnels were left unlined. If the ground was "heavy," timbers were used for support because the cost of stone and brick masonry was almost prohibitive. About one-fifth of the Bergen Tunnel was originally lined with masonry—cut stone for the side walls and brick for the arch. When it became necessary in 1875 to do additional lining and to rebuild the portals, it was decided to try concrete, which was then called *Beton*, the French word for that material. It took the contractor three years to line about 2,000 feet, partly because he was limited by heavy traffic to six hours of work daily. The concrete was, of course, mixed by hand.

The art of tunnel lining has progressed so rapidly and become so economical that it is now general practice to line all tunnels—railroad, aqueduct, or sewer—with concrete whether the rock requires support or not. The needful equipment has more than kept pace with mining machinery, so that a taciturn hard-rock foreman now rarely has to swear at the concrete gang for delaying his miners.

In the beginning, the concrete was placed by hand. Forms, either of wood or steel and with removable plates, were erected. The material, already mixed, was hauled into the tunnel in cars, dumped on the floor, and shoveled into the forms, the form panels being set between the ribs as the concrete rose. This went fast enough until it came to the final operation of placing the concrete directly overhead, or "keying-up." Then only one man could work at a time. Kneeling on a scaffold and shoveling a very dry concrete, he began at the back end of the form and filled the key plates one after another. Occasionally he paused to ram the concrete back against the roof. Hand-ramming of this dry mix did not prevent the concrete from being porous, so that grouting with cement had to be resorted to later to assure watertightness.

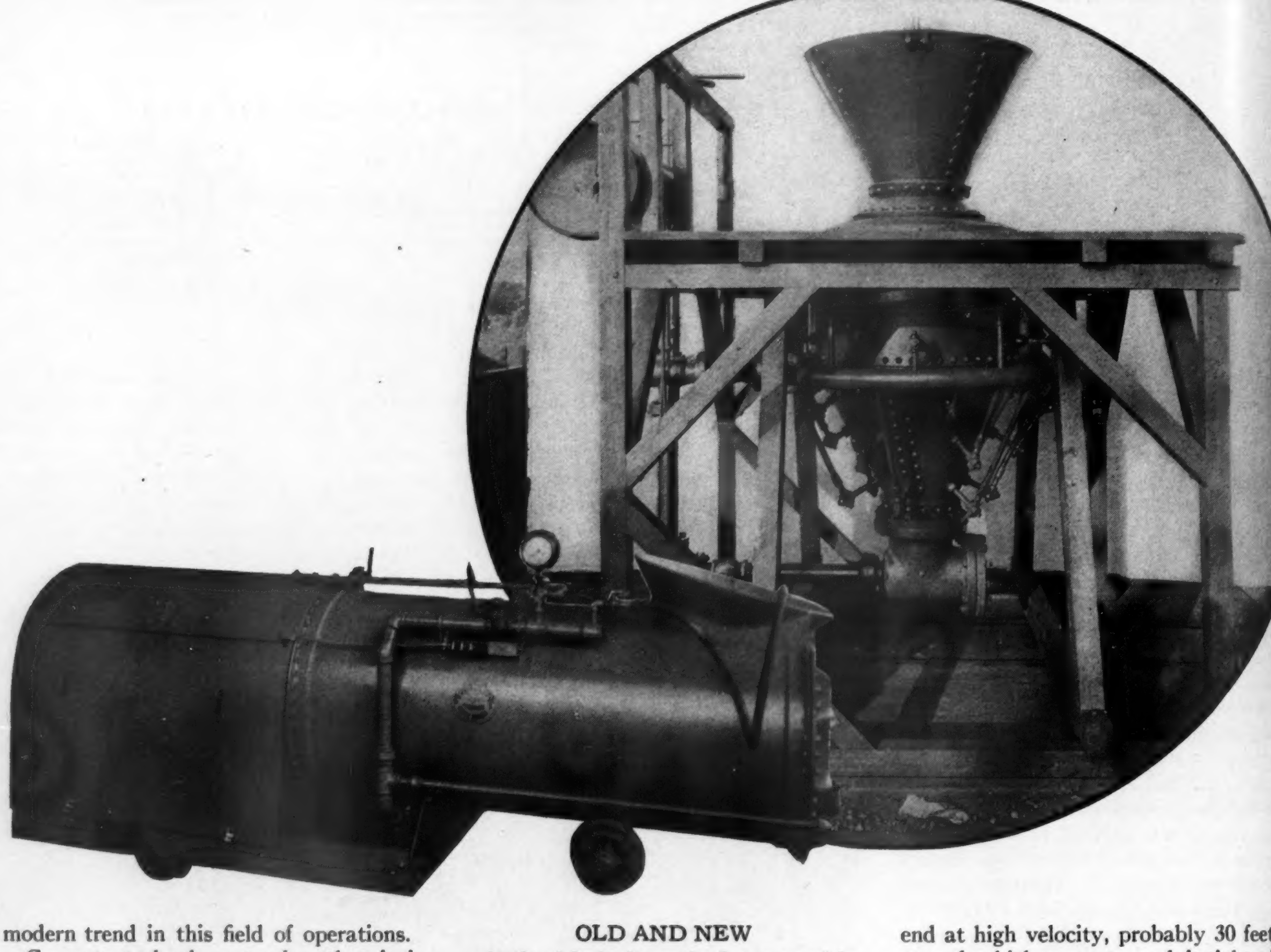
Next, the pneumatic concrete gun supplanted hand-placing—the machine being set against one wall of the tunnel, close to the forms. Concrete was hauled into the tunnel in side-dump cars which were drawn up a ramp and emptied their contents directly into the gun. By this method, tunnels could be lined at the rate of about 40 feet a day. While this was a simple and economical way of doing the work, engineers objected to the long haul of wet concrete; and if any delay occurred at the forms, they were apt to reject a whole trainload because the allowed time lapse between mixing and placing had been exceeded.

The new Los Angeles Aqueduct is 242 miles long, and 91 miles of it consists of tunnels. For lining these long stretches, the contractors, coöperating with the engineers and manufacturers, developed special equipment that would do the work rapidly and economically. The following description of the machinery and methods used on that job will serve to illustrate the



TELESCOPING FORMS

A view that shows how a unit of steel lining forms can be partially collapsed after the concrete placed behind it has hardened, thereby allowing it to be moved through the completed tunnel section and through other forms set up at the opposite end of the series of units. Such forms make tunnel lining a progressive, continuous operation.



modern trend in this field of operations.

Concrete technology teaches that it is necessary to maintain an exact cement-water ratio if concrete of maximum strength is to be obtained with a minimum amount of cement. Mixing concrete outside of the tunnel and transporting it long distances causes segregation of the water and cement, which destroys this ratio and sometimes leads to rejection.

To make concrete at the point of use one must have a special mixer that can work within the narrow confines of a tunnel and yet have a large hourly capacity. These requirements are met by the Dual-Drum mixer, a development of the single-drum mixer of 1-cubic-yard capacity which can produce about 30 batches an hour when the actual mixing time per batch is 1½ minutes. The Dual-Drum mixer has an elongated drum divided into two compartments. A charge of dry materials is taken into the first compartment, water is added, and the ingredients are mixed 45 seconds. The mass is then transferred to the second compartment, where it is mixed another 45 seconds before it is discharged. Meanwhile another 1-cubic-yard charge goes into the first compartment for initial mixing. By thus handling two batches simultaneously the output was stepped up to about 50 cubic yards per hour without increasing the diameter of the drum or the size of the hauling equipment.

The aggregates for the concrete—stone,

OLD AND NEW

At the right is shown the first successful type of pneumatic concrete placer. It was built about 1912. The lower view shows a modern placer or "gun," with positive worm feed.

sand, and cement—are carefully proportioned outside of the tunnel and are transported to the mixer in bottom-dump batch boxes, several boxes to a car. Attached to the mixer is an overhead trolley which lifts the boxes off the cars, one at a time, and dumps their contents into the charging hopper of the mixer. After one train has been unloaded, another one is quickly run in from the nearest sidetrack.

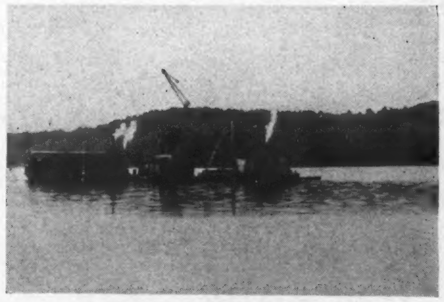
The forms are filled with concrete by means of the pneumatic placer or gun. This is an elongated tank with an airtight charging door at the top and a 6-inch-diameter pipe at the bottom which leads up and over a form. At the point where this pipe leaves the drum is a 2-inch-diameter air jet. Disposed lengthwise inside the drum is a steel worm driven by an electric motor. A 1-cubic-yard batch is taken directly into the gun from the mixer and the charging door closed. The valve on the air blast is then opened and the concrete blown through the discharge pipe at high velocity. Meanwhile the worm inside the gun has been started, and is feeding the material into the air blast in a steady and uniform stream.

The concrete issues from the discharge end at high velocity, probably 30 feet per second, which serves to pack it tight within the form and into all the cavities in the rock, thereby preventing voids and air pockets and assuring a smooth impervious mass. As the form is filled the delivery pipe is withdrawn by moving the entire outfit back, always keeping the nozzle about 10 feet from the fresh concrete.

To one concreting outfit there are generally about 240 lineal feet of steel forms, consisting of eight 30-foot units, each of which is collapsible and made to "telescope" through one another. Thus as concreting progresses, a form carrier picks up and collapses the rearmost unit, telescopes it through those standing in place, and sets it up ahead of the others to be the next one filled. Placing concrete on big jobs has now become a continuous operation, 24 hours a day, seven days a week; and with 240 feet of form, a daily advance of about 200 feet is made.

Tunnel-lining has always been looked upon as drudgery, and the men engaged in that work have seldom received proper credit for what they have done. On the other hand, each time miners have broken a record in tunnel-driving they have received much publicity in all the trade journals. With modern machinery, a concrete gang can line between 4,000 and 5,000 feet of tunnel in a month, an achievement that is rarely brought before the engineering public.

Sand-Hogging in the Ozarks



STARTING A PIER

General view and close-up showing the caisson operations for an offshore bridge pier in Lake of the Ozarks, Missouri. The large picture was taken as workmen were changing shifts. The cylindrical steel caisson extends to a depth of 40 feet below the water's surface. The sand hogs spend nineteen minutes in passing through the air lock to effect safely the transition from pressure below to pressure above the water.

IT MAY sound a bit far-fetched to speak of sand-hogging in excavating for concrete bridge piers rising from the side of an Ozark hill, but, nevertheless, it is true. By way of explanation, however, it should be stated that the hillsides are now under water backed up by Bagnell Dam.

Bagnell Dam was built across the Osage River in south-central Missouri a few years ago by the Stone & Webster Construction Company acting for the Union Electric Company. It is a concrete structure 140 feet high and about seven-tenths of a mile long. It was built to generate electricity, which is fed into the Union Electric Company's distribution system covering the territory from St. Louis south to River Mines.

The dam, in backing up the waters, created one of the most curious reservoirs in the country. Although its surface area at full-pool level is only 95 square miles, the shore line measures 1,300 miles. Viewed from this angle, Lake of the Ozarks, as it is called, is the largest artificial lake in the nation, although its impounding capacity is exceeded by others. The reason for the long shore line is its irregularity.

The Osage River describes a very sinuous course. The lake follows this and takes the form of a succession of serpentine bends that in places almost become loops. The waters are also backed up into a number of tributary valleys which, likewise, are of a meandering nature. As the region is hilly and broken, countless coves extend back for varying distances on either side of these several main arms of the lake. Because of its shape, the width of the lake is not very great at any point, but it has spread out over so much territory that it has broken the continuity of many highways. Immediately after it was created, ferries were provided at the more important crossings; but now new roads have been graded and bridges are being constructed at several points.

In some instances, in connection with the latter activity, conditions call for the sinking of pier foundations by the pneumatic-caisson method; and thus it has come about that sand hogs have invaded the serenity of the Ozarks. Our pictures show the surface operations of a crew engaged in placing footings 40 feet underwater. The total length of the cylindrical caisson is 64 feet. Most of the caisson workers are Negroes. The work is conducted from barges, which carry all essential equipment and have living quarters aboard for the men. The usual regulations governing the hours of continuous work permissible under high-pressure air are in force, and a hospital or recompression lock is provided for the treatment of any sand hogs that may suffer from compressed-air illness.

Recovery of Sulphur from Smelter Gases

IT HAS been estimated that the sulphurous smelter gases wasted annually from stacks the world over contain 2,000,000 tons of sulphur which, at the current market price for crude at the mine represent a loss of $36,000,000. To prevent this, as well as to abate a nuisance that is not only harmful to health but to all vegetation exposed to it, efforts are being made to reclaim the chemical and, apparently, with success.

In a report on the progress that has been made in this respect in Great Britain, Imperial Chemical Industries, Ltd., has announced the discovery of two recovery processes which are being controlled and exploited by it under the name of Sulphur Patents, Ltd. One process was developed at the company's Billingham plant and the other by Bolidens Gruvaktiebolag of Sweden. Both are said to have reached a commercial stage.

The Billingham process, according to *World Trade Notes on Chemicals and Allied Products*, is applicable to metallurgical gases of almost any sulphur-dioxide content. It involves two stages: the first, alone, yields concentrated sulphur dioxide for liquefaction, while the second reduces the pure SO_2 to sulphur by means of coke. Initially, an attempt was made to concentrate the sulphur dioxide from the raw gases; but failing in this, a solution was sought in which SO_2 could be absorbed in large quantities and readily regenerated. A solution of basic aluminum sulphate was chosen. At the works in question, a pilot plant has been in intermittent operation for several years and is now producing about 20 tons of SO_2 gas daily. The associate reduction plant has an output of from 5 to 6 tons of sulphur per day. At a smelter in Finland, the same process is reclaiming daily 52 tons of liquid SO_2 from copper-converter gases containing on an average 5 per cent SO_2.

The Swedish process is better suited for the treatment of metallurgical gases relatively high in SO_2 and low in oxygen content. Reduction of the raw smelter gases is effected in three stages with gases derived from coke: first, manufacture of the reducing gas; catalytic reduction of the SO_2 by means of this gas; and cooling of the gases, together with separation of the condensed sulphur through electrostatic precipitation. At the Bolidens' smelter, at Ronnskar, some 20,000 to 25,000 tons of high-grade sulphur are obtained annually by this process.

PETROLEUM RESERVES

WITH automobiles as numerous as they now are, and with in ternal-combustion oil engines assuming a more and more important position as prime movers for all sorts of power purposes, the matter of our future supply of petroleum is of interest to us all.

It is reassuring to know that such an authority as J. Howard Pew, president of one of the great oil companies of the United States, considers that there is no reason for apprehension over the reserves still remaining in the ground. In a recent address at The Franklin Institute, Mr. Pew cited the great advances that have been made in methods of finding new oil fields, in drilling deeper wells, in producing increased percentages of oil from underground reservoirs, and in obtaining a greater yield of marketable products from that oil in modern refineries, and concluded that no shortage of petroleum derivatives is imminent. As he expressed it: "Without taking into account the certainty that coal and oil-bearing shales can be drawn upon for almost unlimited supplies whenever demand and price shall justify, the facts seem to set at rest any misgivings about where our motor cars will get their fuel in the future."

Mr. Pew's remarks are particularly significant because persons who ought to know have been telling us for many years that our crude-oil reserves were running dangerously low. As long ago as 1908, David P. Day, then Chief of the U. S. Geological Survey, estimated the proven petroleum supply at somewhere between 8,014,000,000 and 22,514,000,000 barrels. Since then, nearly the maximum amount that he mentioned has been produced and millions of barrels have been added to the available supply through new discoveries.

In 1918 another chief geologist, Dr. David White, sounded a warning. If his estimate of the reserves had been correct, we would have been without petroleum for the past seven years. Again, in 1921, another estimate was made. That time, we were informed that there were 9,150,000,000 barrels of crude remaining to be taken from the ground. Since then, production has aggregated 13,000,000,000 barrels, and the proven reserves are greater now than they were in 1921.

All these men were honest and sincere in their opinions, but they did not foresee what was to come in the petroleum industry. They did not envision, for instance, that wells would reach to a depth of more than two miles beneath the surface. They did not know that air-lift and gas-lift were going to increase production from a given oil reservoir. They were unaware of the fact that cracking methods of distilling were to increase the percentage of gasoline obtained from crude oil sevenfold. Nor could they know that hydrogenation was to make it possible to perform the almost unbelievable feat of producing more than a barrel of gasoline from a barrel of petroleum.

Petroleum and its derivatives are inextricably bound up with our national economy. Together with our motor cars, they pay about one-seventh of all our taxes. According to the American Petroleum Institute, our 1937 gasoline-tax bill will be nearly $1,000,000,000. If you are an average automobile owner, you will pay this year into state and Federal treasuries about $32 as your share of this impost. This represents a week's wages for the average person. Since 1930, gasoline taxes have more than doubled. The present average tax is 5½ cents per gallon.

It is estimated that the petroleum industry provides sustenance for 2,000,000 persons in the United States. About half of these work directly in the industry, while the others derive their support from the taxes levied on its products and activities. Thus the taxes collected on the productivity of each man engaged in the production, refining, or marketing of petroleum and its derivatives pay the wages or salary of another man on a public or industrial payroll. A great many of those in the second class work on highway-construction jobs that are financed by gasoline taxes, or in factories that turn out machinery and materials entering into such construction.

DRILLING-EQUIPMENT REFINEMENTS

THE first mechanical rock drills, crude though they were, nevertheless made possible great savings in time and in human exertion, as compared with the hand-drilling methods which they replaced. A review of the advertisements of drill manufacturers of the 1870-1890 period shows that the makers believed firmly that they were approaching perfection.

Looking backward, we now know that they had merely made a beginning towards efficiency. Compressed air, with its manifold advantages, was to take the place of steam for operating the drills; the self-rotating, hammer-type drill was to supplant the slower-acting piston drill with its rigidly held drill steel; hollow drill steel was to be developed with its beneficial effects, permitting, as it does, air and water to reach the bottom of the hole and to keep it clear of cuttings; valve action was to be improved; and the reciprocal motion of the piston speeded up.

When we think of the vast betterments that have gone before, it would be foolish to predict that no additional major improvements will be made in rock drills. Yet it is true that a point has been reached where gains in drill performance result chiefly from the cumulative effect of continual refinements rather than from radical departures from established principles of design.

The advent of the automatic feed for drifter drills has served to increase greatly the work a drill will do, yet it represents a change in the technique of operation rather than in the drilling mechanism itself. Similarly, the mounting of wagon drills on carriages that can be moved and maneuvered quickly and easily increases the drilling efficiency without altering the central unit. Some old-time hard-rock men might scoff at drills mounted on pneumatic tires; but the inescapable fact remains that they make it possible to do more drilling per day with the expenditure of less human energy.

Universal Pneumatic Die Cushion for Punch-Press Work

AFTER considerable experimenting with different types of pneumatic die cushions for both high-speed shallow drawing and various compound blanking and stripping operations, the Dayton Rogers Manufacturing Company has introduced a universal, self-contained portable unit that can be quickly attached to any punch press. It consists essentially of a heavy cast-iron-alloy air cylinder that can be clamped directly to a press bolster plate for shallow drawing or mounted clear of the bolster plate by means of four spacing studs for compound blanking work. Installation is made through the hole in the punch-press bed, and power is taken from the shop air line and regulated by a suitable valve to meet the needs of each job.

The piston, the top face of which is hardened and ground to back up draw-ring pins, is guided by a long rod or leader pin that projects through the bottom of the cylinder, where it is threaded and affixed to a handwheel. By this arrangement it is possible to adjust the height of the piston easily and with precision for a wide variety of punch-press operations, as well as to prevent piston deflection—that is, to hold all pressure pads, stripping plates, and draw rings rigidly in working position without the use of rubber or springs.

This universal pneumatic die cushion comes in seven sizes ranging in over-all height, including the handwheel, from 11½ to 15¾ inches and in maximum diameter from 4¾ to 15½ inches. With compressed air at 100 pounds pressure in the line they are said to assure a draw-ring holding pressure of 1,200, 2,000, 2,666, 5,000, 9,000, 11,000, and 15,000 pounds, respectively.

Special Reel for Air Hose

AIREEL is the trade name of a new hose retriever that is designed for use with compressed-air tools, paint-spray and blow guns, and other similar portable pneumatic equipment. Tangles, twists, and kinks in air lines, the bane of operators, are avoided by it because it always draws the hose back in good order under a constant set tension and thus keeps it off the floor.

The reel can be attached to the wall or ceiling, and is connected with the air supply through a pipe fitting beneath the mounting plate. From the fitting a short length of pipe leads to a swivel joint, at the hub, to the inner side of which the hose is attached. After being properly wound, the loose end is passed through an adjustable guide held in position by a movable arm on one side of the retriever. The swivel joint also is self-adjusting; and air up to 150 pounds pressure may be used.

There are five sizes to choose from for pneumatic-tool application: three, with a diameter of 19½ inches each, for 25 feet of air hose of ¼, ⅜, and ½ inch inside diameter, respectively, and two, each 30¾ inches in diameter, for 50 feet of ½ inch and ¾ inch hose. Standard types for paint-spray and blow-gun work, which requires two lengths of hose, differ slightly in construction and include a duplex air-fluid reel for spray-booth service only.

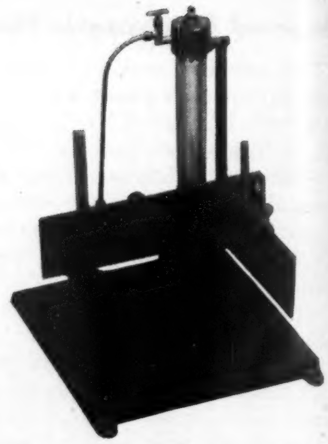
One-Man Pneumatic Concrete Gun for Patchwork

AMONG the manifold tools and equipment used in the construction of the Colorado River Aqueduct is a small grout ejector that is familiar to contractors on the West but not on the East Coast. It is known as the Mack Mortar Gun, after its inventor, L. E. McCormack, who has had charge of some of the "gun work" on that 241-mile conduit which is being built by the Metropolitan Water District of Southern California to supply water to thirteen cities in that region. It is a one-man portable unit designed for patch and repair work that is generally done by hand because it does not justify setting up a large-size machine.

As the accompanying illustration shows, the ejector consists of three parts—of a hopper, of an elbow with a ½-inch air connection, and of a nozzle or discharge pipe. A mix with the consistency of plaster is used, and in the case of the aqueduct has been made up of about one part of cement to three of sand, with just enough water added to permit the material to flow. Feed is by gravity assisted by suction, which is induced by the compressed air admitted directly beneath the hopper; and the air supply is controlled by the operator—the gun being held so that he can conveniently manipulate the air valve at all times. Air at from 50 to 60 pounds pressure has been found most effective, and is said to apply the mortar with sufficient force to pack holes and to do other necessary patchwork with little rebound or waste of material. The gun will place 2½ and more cubic yards in an hour, and as many as twenty wheelbarrowfuls have been shot with it in the same interval.

As many as sixteen of these handy ejectors have been in use on the Colorado River Aqueduct, and they have considerably simplified the work of smoothing and filling up all imperfections in newly poured concrete—including cracks, gravel pockets, tie-bolt holes left by the forms, etc. They have also been found very helpful on the West Coast in repairing concrete structures damaged by earthquakes; and one is being employed by the Bureau of Water and Power of the City of Los Angeles on the Mono Craters Tunnel. Strength tests made by both the City of Los Angeles and the Metropolitan Water District have proved that mortar so placed meets the usual requirements.

Gasoline in Paste Form Runs Engine



FIVE quarts of gasoline jelly, please. This may not be as fantastic as it sounds, for it has been announced that Dr. Adolph Prussin, of New York, has succeeded in "solidifying" gasoline after years of experimenting. The object, of course, is to increase its factor of safety, especially in the field of aviation. The fuel produced by Dr. Prussin is in the form of a reddish paste, and has been tested at the Guggenheim School of Aeronautics at the New York University in connection with a single-cylinder engine that functioned as well when driven with the jellied as with the liquid gasoline. To determine the explosibility of the solid fuel, four incendiary bullets were fired into a 5-gallon can of it with an army rifle at a range of 25 feet. Nothing happened after the first three shots, according to the reports; but the fourth bullet ignited the gasoline, and then only because some of it had been liquefied as the result of pressure and spilled on the ground.

Pneumatic Stripper for Handmade Cores

TO FACILITATE the production of hand-made cores, there has been developed a Quickdraw core stripper that is operated with compressed air. The device is the invention of Myron C. Kline, and is arranged so that it can be conveniently mounted on a work bench and controlled by a foot valve, leaving the hands free. It consists mainly of a 14x14-inch base, of an angular stripping frame which has an upward travel of 6 inches along vertical guides, and of a vibrator that transmits its motion to the base.

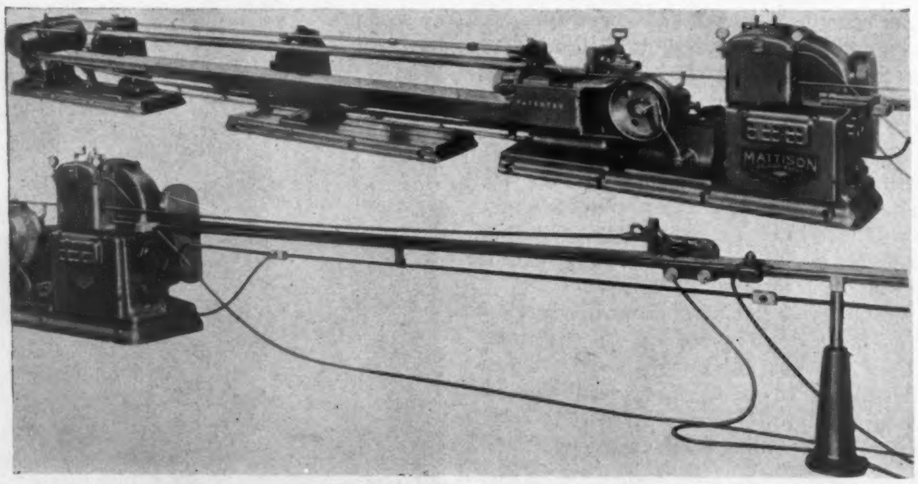
The use of the Quickdraw involves no change in core-making. After a core has been rammed up it is rolled over on the core plate and the box and plate placed on the machine and held by the operator against the stripping frame. He then starts the vibrator by slightly depressing the foot valve. In less than a second the core box is shaken free and the stripping frame begins to rise, carrying the box along with it. As soon as pressure is released the machine stops and the stripper drops to its starting position, which can be regulated by means of a stop pin.

According to the manufacturer, the machine will strip any box within its limits, whether round, oval, or square, provided the sides are at an angle of 90° to the face. Boxes that are too large or too heavy to be held securely against the stripping frame can be lifted by it if given a false bottom with a ¼-inch projection against which the frame can bear in its upward travel. By eliminating all destructive hammering or rapping, the Quickdraw will, it is claimed, turn out perfect cores of uniform size and, in addition, increase the life of core boxes. Except for regular oiling, the mechanism requires little attention.

All-Purpose Internal Tube Grinder

GRINDING and polishing is an important phase of the manufacture of certain classes of tubing which, because of the work performed by them, must have a smooth inner surface free from pits and other imperfections. This applies especially to piping designed to handle products for human consumption, as well as to boiler tubes and tubes used to transfer oil and other fluids that have a tendency to leave a deposit or to build up scale. Obviously, smooth and highly polished surfaces are not so readily coated as are rough ones, are easier to keep clean, and lessen friction.

For this finishing work the Mattison Machine Works has developed an ingenious grinder that can accommodate pipes of stainless, alloy, and carbon steel, bronze, brass, composition, etc., ranging from ⅝ inch inside diameter to 9 inches outside diameter and from 15 to 50 feet in length. Grinding is done by a flexible abrasive belt, the grade used depending upon the finish desired. This belt is passed through the tube and made endless by a piece of cement-coated tape that is affixed in about half a minute by an electric heating iron which is an integral part of the equipment. The tape is removed in the same way and can be employed over again like the belt, which goes around a pulley on a driving motor at one end of the machine and around an idler with a tensioning device at the other end.



INTERNAL TUBE GRINDER

In the upper picture is shown the set-up for a 25-foot-long tube, which is in grinding position between the telescoping water-spray pipe and trough. Immediately above the abrasive belt entering the right-hand end of the tube is the expansible head attached to the hollow ram rod, which is seen in detail in the lower part of the illustration. The entire machine requires 5x71 feet of floor space, and for each additional 5 feet of tubing the over-all length of the grinder is increased by 10 feet.

When in place, pressure is applied to the belt to bring it in contact with the tube walls. This is done by means of an expansible head attached to a hollow, power-driven ram rod through which compressed air is fed to spread the head and to hold it apart. At the end of each stroke the ram is automatically reversed, and the pipe, which is mounted on rubber-faced supporting and driving rolls, is rotated during the course of the grinding operations. The air pressure applied to the head, the speed of the ram rod, and the number of revolutions of the tube per minute are all variable and under constant control, and overheating of the metal is avoided by a water-spray pipe which, together with its trough, is made to telescope, thus permitting one machine to handle tubes of varying lengths. The entire set-up is very flexible, as it must be to meet the requirements of different metals and to give the tubes an inside finish ranging all the way from a superficial one, involving perhaps the removal of scale, to one that is smooth and highly polished.

Industrial Notes

A liquid drier recently placed on the market permits the application of paints, varnishes, lacquers, and primers on damp or wet surfaces. It is mixed in the proportion of 5 parts of compound to 95 parts of paint, and comes in 1-gallon containers.

Air-Maze Corporation, 812 Huron Road, Cleveland, Ohio, has announced that its 1937 catalogues descriptive of its complete line of Air-Maze filters for industrial and automotive service are available for free distribution.

The Industrial Research Institute of Tokyo has announced the development by one of its engineers of a process for the production of synthetic peppermint. No information regarding it has been disclosed other than that it requires the use of chlorine, a by-product of the country's soda industry which has until now had trouble in disposing of that waste material.

Distant reading of water gauges either day or night is made possible by a new combination illuminator and magnifier. The device consists of a Neon tube, with leads for the necessary electrical connection through an integral transformer, and of a magnifying glass. It is mounted behind the gauge, and when in service indicates the liquid-filled part by a broad red band and the remaining unfilled end by a narrow red line.

In its search for a self-lubricating bearing, the Chrysler Corporation has produced a metal compound that absorbs and holds oil like a sponge. It is claimed that if a piece of it is put in a vise and pressure is applied, the oil will ooze out in big drops. The material is known as Oilite, and has many applications. It is made into hundreds of sizes of plain, flanged, and thrust bearings which, among other things, are shown in a catalogue recently published by the company.

Clay and asbestos are being used in the Philippine Islands to make a roofing tile suitable for light construction. It is the product of Dr. Salvador del Mundo, chief of the ceramics section of the Manila Bureau of Science, and compares favorably with the more expensive run of tiles generally utilized there. It is composed of from 70 to 50 per cent clay and 30 to 50 per cent short-fibered asbestos, is fireproof, serves as an insulator against heat, and is sanitary because it offers no breeding places for vermin.

Under the name of Airefiner, Oakite Products, Inc., is offering a colorless, nontoxic material that is said to prevent the growth of slime and algae in water. Although it can be used to sterilize water for various purposes, it is primarily intended for service in connection with air-conditioning systems in which the water is recirculated. It is sold in quantities of 10, 45, 135, and 400 pounds, and the company is prepared to fill trial orders.

Highway hotels are the newest thing in hostelries on the Continent of Europe. The first of them is being erected on the Berlin-Magdeburg-Hannover *Autobahn*, and consists of two structures, one on each side of the road, connected by an underground passageway. It includes a restaurant and sleeping quarters for truck drivers on the ground floor, a restaurant for the traveling public on the second floor, four parking places, two filling stations, and a repair shop.

From a foreign source we learn of a dust-collecting machine that is designed not for cleaning city streets but for country roadways. It is described as a wheeled container carrying a rotating brush which picks up the dust and throws it against a projecting shield, whence a blast of compressed air carries it up through a curved channel into the body of the vehicle. There the material is intercepted by a screen which permits the air to escape. In making test runs with the machine, mostly over gravel roads, it was found that nearly 99 per cent of the sweepings passed through 0.004-inch mesh.

Xaloy, which has been used under the name of I. R. Metal in the manufacture of oil-well equipment, has been made available for general industrial application by the Wilcox-Rich Corporation under a license from Industrial Research Laboratories, Ltd. The alloy is said to have a tensile strength of 43,000 pounds per square inch, a compressive strength of 240,000 pounds, and a Brinell hardness of 750. It is cast on parts exposed to abrasion, such as bushings and rollers used in working with cement, sand, gravel, crushed stone, coal, ashes and the like, as well as on dies, briquetting molds, packing glands, cylinders, valves, etc., etc. It is said that the resultant bond is a perfect one and that the linings or coatings are highly resistant to wear.

A bulletin that should be of considerable interest to garage and service-station men has been published by Ingersoll-Rand Company. It describes and graphically illustrates the full line of single- and 2-stage compressors, ranging in size from 1/4 to 10 hp., built by that company to meet their needs. Of particular value to them will be several pages in the back of the book explaining in simple language and with thumbnail sketches how a 2-stage compressor works and showing how much air it takes for individual tools and services. This will help them to understand the 2-stage unit and to make their own selection of machines, which should, preferably, be large enough for their immediate requirements and for reasonable expansion. The catalogue, No. 7501-H, can be obtained by writing to the company at 11 Broadway, New York, N. Y.

Split Sleeves for Quick and Permanent Pipe Repairs

BECAUSE of the growing demand for its split sleeves for the repair of all kinds of pipe lines, S. R. Dresser Manufacturing Company, Bradford, Pa., has announced that it will carry a full and complete stock so as to be able to meet any demand without delay. They come in various styles and sizes. Styles 73 and 52A, for example, are designed for sealing steel pipes, or joints in such pipes, which are subjected to a maximum working pressure of 250 and 500 pounds per square inch, respectively. Style 57 is for the straight run of cast-iron pipe; Style 26 for mending broken bells or cast-iron pipe close to bells; and 54A for bolted joints in steel piping.

Dresser split sleeves effect permanent not temporary repairs, and permit full or partial service to be maintained while they are being applied. According to the manufacturer, it takes only a few minutes to do the work because the only tool required for it is a wrench, there are no joints to pour and calk, and, in the case of underground pipes, a "dry" hole is not essential. If necessary, the sleeves may be put in place underwater, and two or more can be joined to cover a break more than 8 inches long.

TYPICAL BREAK AND REPAIR JOB

This 4-inch water main was made tight with a Style 57 split sleeve applied with nothing more than a wrench.